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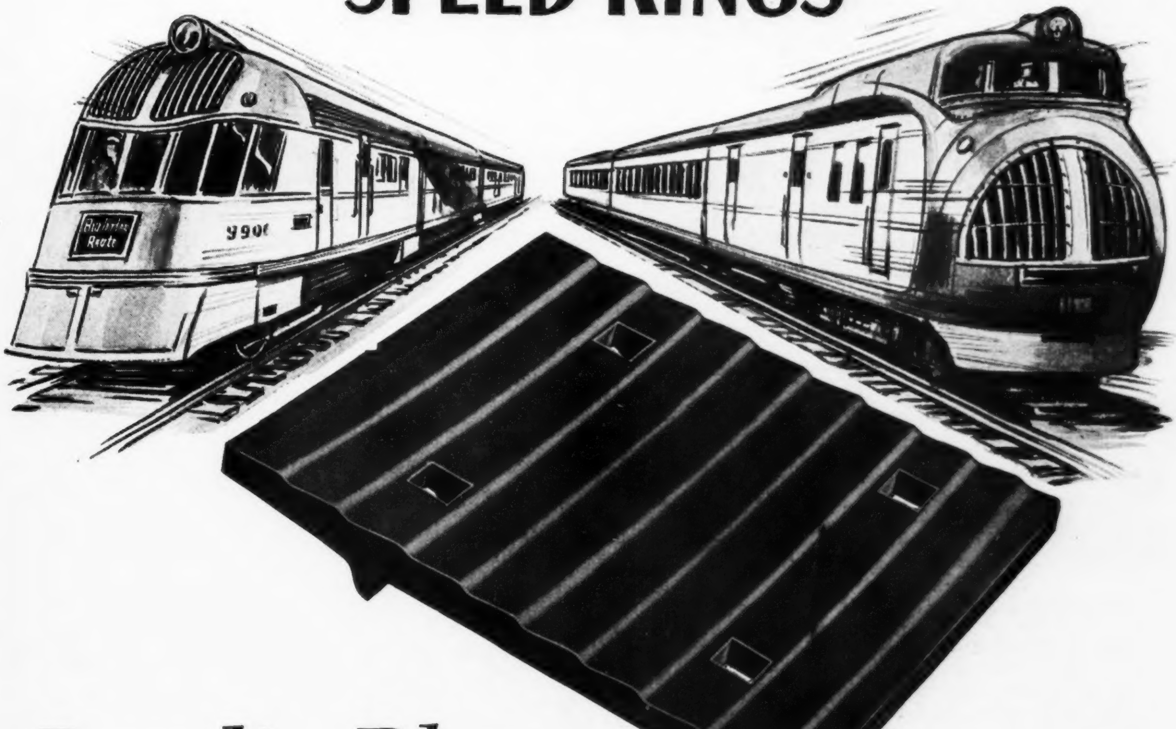
STRONGER TRACK *for the* SPEED KINGS



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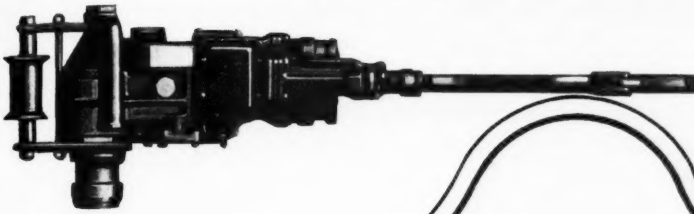

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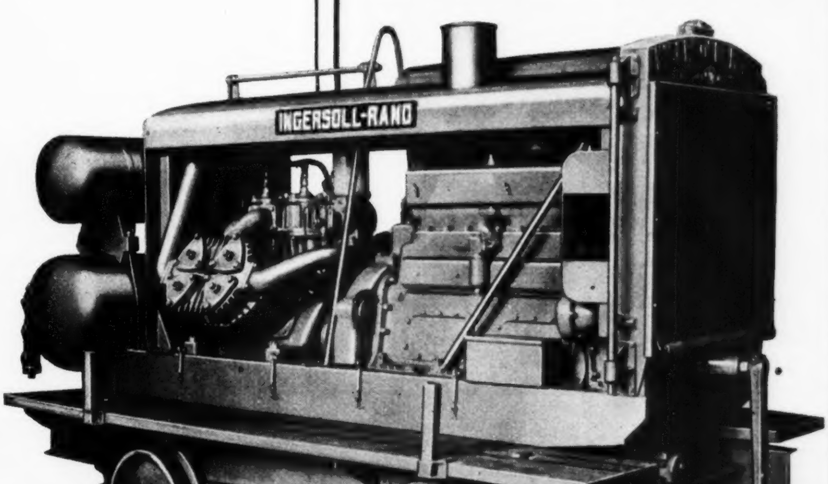

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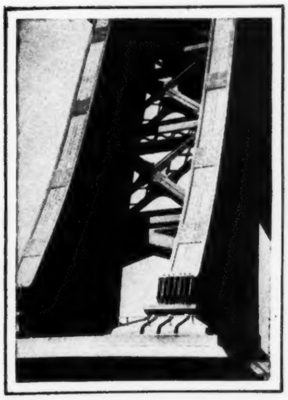
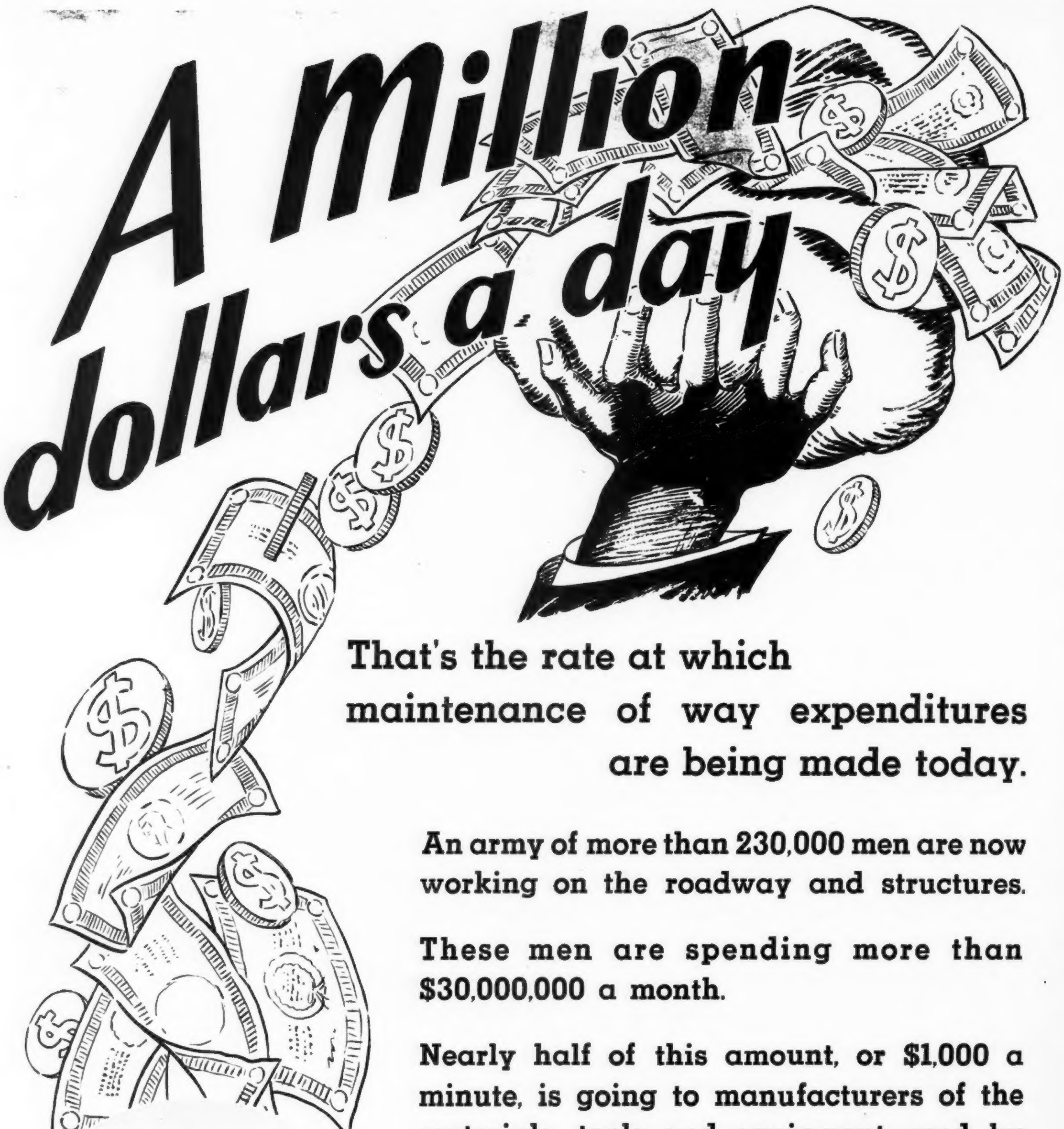


A Million dollars a day



That's the rate at which maintenance of way expenditures are being made today.

An army of more than 230,000 men are now working on the roadway and structures.

These men are spending more than $30,000,000 a month.

Nearly half of this amount, or $1,000 a minute, is going to manufacturers of the materials, tools and equipment used by these men.

This is the market pr sented by the readers of Railway Engineering and Maintenance.

Are you, Mr. Manufacturer, telling the story of your products to these men and thereby making a bid for this business?

RAILWAY ENGINEERING AND MAINTENANCE IS READ BY MAINTENANCE OFFICERS OF ALL RANKS

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And when it comes to rail grinding, the cost of doing it with modern grinders is so low that there simply is no logical substitute. For modern track grinders, come to world headquarters:

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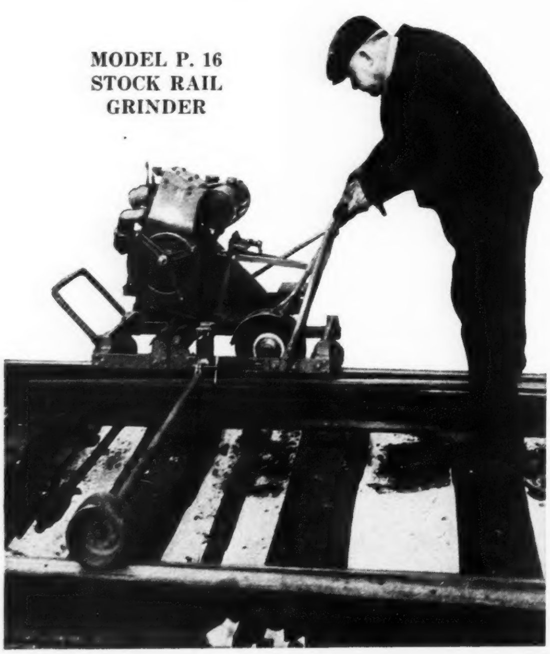

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WHERE RIGHT-OF-WAY DRAINS ADJACENT LAND.. USE

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CORRUGATED PIPE

In too many instances, a railroad right-of-way forms a reservoir for drainage from surrounding lands. Excess water runs off the adjacent land and collects in the drainage ditches on the railroad. If drainage facilities are inadequate, trouble is usually encountered when run-off is heavy. Silt is washed into the ballast, ditches are eroded and often even the track itself is rendered unsafe. The water backs up on the surrounding land, sometimes causing considerable damage to crops, as well as saturating the railroad roadbed.

The remedy is simple. The difficulties can be overcome by proper use of the particular type of Toncan Iron Corrugated Pipe suitable to the condition encountered. The photograph illustrates the proper drainage of a low spot adjacent to the railroad fill. Toncan Iron Corrugated Pipe is placed through the sub-grade at a suitable distance below the ballast, and the low spot is drained into an adequate drainage system.

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No. 70 of a series

Railway Engineering and Maintenance

SIMMONS-BOARDMAN PUBLISHING COMPANY

105 WEST ADAMS ST.
CHICAGO, ILL.

Subject: Arteriosclerosis.

September 27, 1934.

Dear Reader:

In these days of strain and worry, physicians tell us that more of us are developing arteriosclerosis, or hardening of the arteries. This is a disease that normally comes with advancing age, not measured necessarily by years but more accurately by the wear and tear of the human body. The effect is to slow down the individual and make him less active and energetic.

Of late, the railway industry has begun to move with startling rapidity. Streamlined trains running 110 miles per hour, freight train schedules exceeding those of passenger trains of a few years ago, storedoor pick-up and delivery of freight, are indicative of innovations that are appearing in all quarters. In maintenance of way, the transfer to specialized gangs, mechanically equipped, of such tasks as the tightening of bolts and the renewal of ties, long considered as inherently the work of section gangs; the necessity for perfecting the track for speeds of 100 miles per hour or more where 60 to 70 had been the maximum heretofore, etc., are equally revolutionary.

Such changes demand of us alertness, initiative and, above all, an open mind in order that we may recognize and accept the good, while avoiding the impractical. Not all of the proposals now being advanced will prove out; neither will all the forecasts of failure. The present period of rapid transition calls for a sympathy of attitude and a willingness to try new ideas that are characteristic of youth. This is no day for one with "hardening of the arteries", mentally or physically.

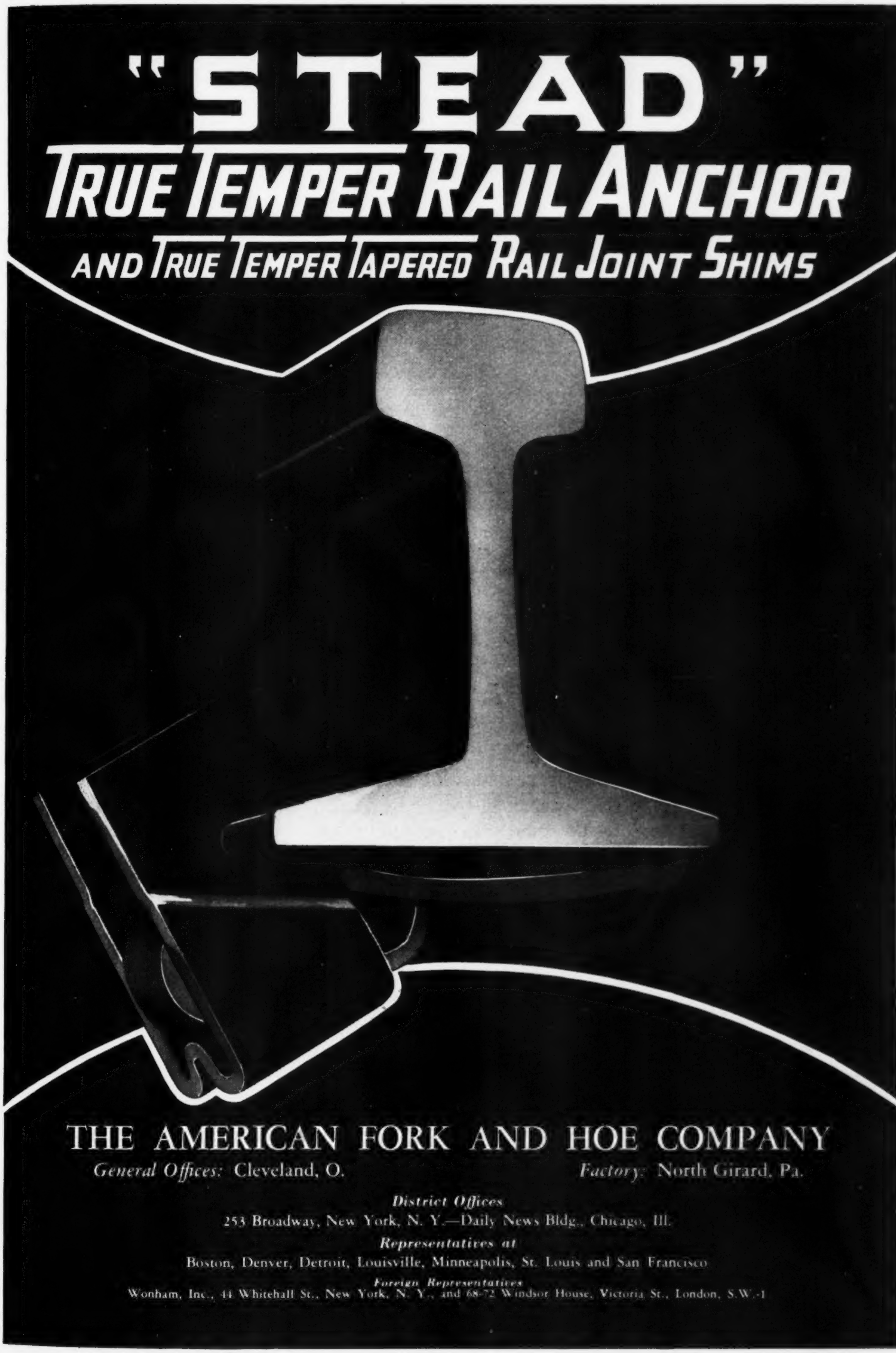
Yours sincerely,

Elmer T. Howson

ETH*JC

Editor.

MEMBER: AUDIT BUREAU OF CIRCULATIONS AND ASSOCIATED BUSINESS PAPERS, INC.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AND TRUE TEMPER TAPERED RAIL JOINT SHIMS
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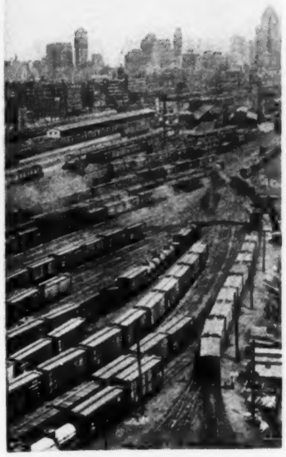

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Railway Engineering and Maintenance

NAME REGISTERED U. S. PATENT OFFICE

October, 1934

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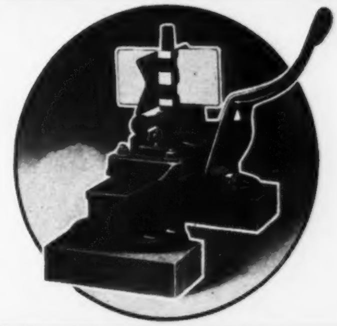
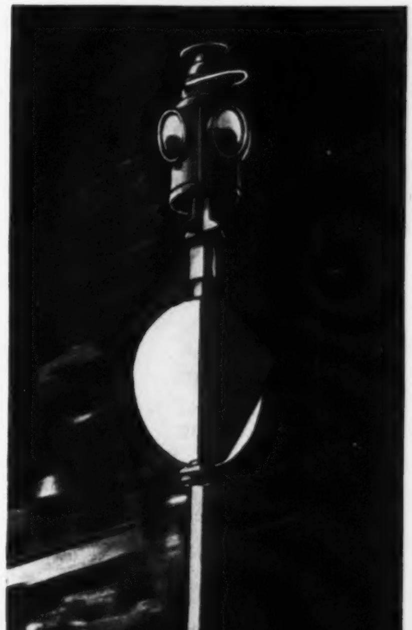





SAFE · AUTOMATIC ·
POSITIVE · ECONOMICAL

Railway Engineering and Maintenance

COMMUNITY PROSPERITY

Linked with Well Being of Railroads

THE editors of three newspapers have written this editorial. Prompted by a common interest in the welfare of their respective communities, even though widely separated, they have come to a common conclusion. What has happened in these communities is happening in varying degrees elsewhere. The conditions giving rise to these editorials are not peculiar to the communities specifically mentioned but can be duplicated in thousands of other communities throughout the land. They constitute so serious a threat to the continued prosperity of so many of these communities that railway employees should see that those in their respective localities are fully appraised of the facts concerning the present situation and its logical outcome.

From Memphis, Tenn.

The first of these editorials is taken from the Memphis, Tenn., Commercial Appeal and is entitled, "Why We Ship by Rail." It reads as follows:

"Five thousand Memphians get their pay checks every month from railroads in Memphis. They are industrious, frugal, law-abiding, intelligent, community-building citizens.

"Memphis became a great city because it was a great railroad center. Memphis is now suffering from neglect of a system of transportation that made it great.

"In 1929, there were 7,000 officers and employees of railroads living in Memphis. Business diverted from railroads has cost 2,000 employees their jobs. The 5,000 remaining employees must be kept on the job and the other 2,000 restored if Memphis is to retain its prestige as a great retail market.

"The Commercial Appeal is doing its part to keep railroad men on the job. Four hundred and twenty-five cars of print paper are shipped to the Appeal papers annually from Canadian mills by all-rail route. This means $120,000 a year paid to the railroads in Memphis by the Appeal papers on freight for inbound newsprint. The Appeal papers are delighted to patronize the railroads, as an obligation to their fellow citizens as well as for efficient service.

"Five thousand railroad employees in Memphis represent a monthly payroll of approximately $1,000,000. Railroad men are good spenders. They live well. They buy food, fuel and actual necessities as liberally as incomes permit. They buy good and stylish clothes, automobiles, radios, furniture and indulge themselves in luxuries whenever possible.

"A good railroad town means a good town. Memphis can be made a much better town by a more liberal patronage of the railroads. The greater part of the money paid to the railroads for freight goes into local payrolls. Every enterprise in Memphis owes a duty to an important factor in its trade to support the railroads."

From Statesboro, Ga.

The second editorial is taken from the Statesboro, Ga., Times and News. It reads as follows:

"The announcement during the week that Statesboro is to lose bodily one of its railroads comes as a shock even to those who have known all along for years that it was inevitable.

"Since it is a trait of human nature to hope for the best, those who were aware of the dire straits under which the Savannah & Statesboro has labored for years had hoped for something to turn up. The thing that has turned up is the worst thing that could happen—the road announces that it cannot longer exist.

"This situation is not one which can be met by any sort of assembling and adoption of resolutions. It takes more than resolutions of regret to sustain railroads and meet payrolls. It takes business which turns in cash. That is exactly what the Savannah & Statesboro has been needing and which it has not received in sufficient volume.

"And now we have been brought face to face with modern conditions. Improved highways and modern means of transportation have borne their fruit.

"The railroads have served us and labored among us—have contributed by taxation and public spirit to every forward movement—and have reaped the fruits of their contributions.

"Improved highways, built largely by taxation to which the roads have contributed, have undermined the railways. Trucks and buses have taken that business which was necessary for the life of the railroad. Cotton warehouses located within a stone's throw of the Savannah & Statesboro freight warehouses have poured out a stream of cotton on trucks—hundreds of bales per day—while the railroad was being starved for revenue with which to pay its employees. Private trucks have brought from the markets of other towns and even other states the freight which would have meant the continued life of the Savannah & Statesboro Railroad.

"Merchants in Statesboro patronized trucks for the saving of a few cents per hundred pounds, while the railroad was turning off its employees—patrons of those

same merchants—because the road had no work for them nor money with which to pay their wages.

"There was a time when the people of Statesboro were aggressive enough to fight for the life of their community. Old-timers put their hard earned cash into railroad stock as inducement for their building to help the town. New-time business men have permitted the railroads to starve and drop out of sight to save a few nickels in the cost of freight. No bus or truck line ever built a town. No town which is dependent upon buses or trucks for its transportation is adequately supplied with transportation."

From Denver, Colo.

The third editorial was taken from the Denver, Colo., Post, from which the following quotation is taken:

"Abandonment of 30 miles of narrow gage track in Archuleta county by the Denver & Rio Grande Western Railroad has been authorized by the Interstate Commerce Commission. The county commissioners, the town of Pagosa Springs and the state all opposed the application. Abandonment of this line wipes out $733,150 of assessed valuation upon which the Rio Grande has been paying taxes. That is one-half of the total assessed valuation of the county. Losing the taxpayer who carries half of the tax burden is a severe blow to any county. But a railroad line cannot be operated indefinitely at a loss merely to continue as a revenue producer for the tax-spenders."

By reason of the character of their service and the number of persons which they employ, the prosperity of the railways is essential to the well-being of the communities, a fact which, as in Memphis, should be recognized before it is too late to avoid the fate that has already befallen Statesboro, Pagosa Springs and hundreds of other communities in this country.

OPTIMISM

Conventions Point to Better Times

AT the time of the last convention of the Roadmasters' association, the unfulfilled promise that, "Prosperity is just around the corner," was quoted almost daily. Today almost the only comment to be heard, and that infrequently, is, "Wasn't the depression terrible!" While the latter implies a flippant disregard of the hardships with which many must still contend, it is truly characteristic of the spirit that is leading us to better days.

However, there is much more tangible evidence of the turning of the tide in the holding of the Roadmasters' convention after a lapse of four years, to be followed in October by a convention of the Bridge and Building association after a like period of inactivity. These two groups possess enviable records. Organized in 1882 and 1891, respectively, they held conventions every year up to and including 1930, and during the World war were numbered among the few associations of railway officers whose work was deemed of such importance by the Railroad administration that they were especially encouraged to proceed with their conventions in both 1917 and 1918, when most of the others were instructed to abandon their meetings.

That, in the face of this record, those two associations should have been asked to give up their conventions in three succeeding years, is convincing proof of the dire straits of the railroads during that period. And for that very reason, the granting by the American Railway Association of authority to hold the conventions this fall is an emphatic demonstration of the change for the better.

TRESTLES

Not Too Old for Further Improvement

IN 1929 the Committee on Wooden Bridges and Trestles of the American Railway Engineering Association was instructed to investigate the opportunities for improvement in the association's standard plans for wooden trestles, but after pursuing its study of this assignment for two years, it reported in 1931 that, "the plans now in the Manual comply with the requirements of economy in design and the conservation of timber resources."

That this view is not universally held is demonstrated by the fact that several roads have considered the shortcomings of their past practices in trestle construction of sufficient moment to warrant the development of new plans embracing a number of innovations. The reader is referred to *Railway Engineering and Maintenance* for April, 1931, and to the June issue of the present year, respectively, for descriptions of the new standard trestles of the Burlington and the Santa Fe, and the September issue for a description of the new plan recently adopted by the Southern Pacific Lines in Texas and Louisiana. While these three designs differ to an extent that may justify some doubt as to the early success of efforts to incorporate these new ideas in a revised A.R.E.A. standard, there can be no question as to the importance of the considerations that prompted these endeavors at improvement. Surely they are worthy of general study.

Foremost among the objectives sought is greater facility in framing before treatment, a practice that was undreamed of when the conventional trestle plan was evolved. But this is not all, for dissatisfaction with the drift bolt as a means of attaching the cap to the piles or posts, and the chords to the cap has been responsible for further innovations. That timbers held together by drift bolts "stay put" is conceded, but it is to be questioned whether those who must dismantle such a connection derive as much satisfaction from it as those who put it together, especially when it is desired to salvage the timbers without impairing their remaining service life.

It is to be observed, also, that much of the effort to improve wooden trestle construction has been focused on the cap. The result in the design featured in this issue is especially noteworthy and comprises a marked departure from the conventional. It is of interest to note, also, that the objectives which gave rise to this design have led the Northern Pacific to adopt a steel beam as the cap for wooden bents as described on page 542 of this issue.

The fact that a type of structure as old as the timber

trestle should be the subject of serious study in this late day, and that the resulting revisions in plans vary so widely in numerous details, should demonstrate that there is still room for further investigation. In the meantime, advance in reinforced concrete trestle practice and the advent of the wide-flange steel beam bring to the fore two active contenders for the dominant position which the wooden trestle has long enjoyed in the field of the multiple short-span structure.

RELEASED TURNOUTS

Should They Be Used with Relayer Rail?

IN VIEW of the rail orders that have been placed in recent months, it is to be expected that more second-hand rail will be relaid this season in secondary and branch line tracks than in any season during the last five or six years. This brings to the fore the question that always arises in connection with the use of released rail as to whether it is good practice to re-use the turnouts released with the rail, or to provide new material? Under present conditions this question is given added prominence by the fact that every maintenance officer is striving to make the available funds go as far as possible and still maintain his tracks to acceptable standards.

Released rail is commonly expected to have at least as long a life in a secondary track as it had in its original location. Frogs, switches and stock rails, however, usually wear more rapidly than the adjacent rail. When turnout movements are frequent, this is also true of the lead rails. For these reasons, many roads have, during normal times, insisted on new turnout material when laying released rail. On the other hand, some hold the view that the full section of the new material does not fit up with the worn section of the released rail and that it is preferable, therefore, to use the released turnouts for this purpose.

Owing to the greater wear to which the released turnouts have generally been subjected, it may be accepted that their life after relaying, even in secondary tracks, is relatively short, and when renewal becomes necessary, therefore, the same problem arises as if new materials had been used at the time the rail was relaid. In other words, when old turnouts are used, the problem is not solved but only deferred.

Normally, when rail is released, most of the joints are battered, even where modern methods of building up the rail ends are followed. In this event, the ends of the rails adjacent to and through the turnout should be built up by welding, even though this may not be done for the rail as a whole, and if this is done, one of the important objections to the use of new material will be removed, at least in part.

Is there greater economy in the use of old material than new? Superficially, at least, it might seem that the former would be more economical. Every road has, however, many inside turnouts that are used infrequently or for slow-speed movements, where the released material can be used. If installed in such a location, this material should have an additional service life equal to or greater than that of new material in main-track service, whereas, if continued in main-track service, its life will be relatively short. It would seem, therefore, that on the basis of physical conditions, ultimate economy and, in many instances, of immediate expenditure, the use of new turnout material in connection with released rail is more advantageous than the re-use of the released turnouts in main tracks.

CURVE WEAR

What the Section Forces Can Do About It

WITHIN recent years equipment has been developed for oiling the flanges of wheels and the side of the rail head to reduce wear. Still more recently this equipment has come into widespread use in nearly every section of heavy curvature in the country. While it has demonstrated both effectiveness and economy, in that the service life of the rail is extended and maintenance is reduced on those curves where it is installed, it is not a substitute for careful maintenance, nor is this claimed for it, and its use does not relieve the section forces of any of the responsibility which they must assume on curves not so equipped.

It is difficult to differentiate between the relative importance of superelevation, line, surface and gage when one is considering their effect on either rail wear or the riding qualities of a curve. Some trackmen are inclined to place uniformity of superelevation before all of these. Yet when one considers that if the line varies by so little as one-fourth of an inch the resulting variation in the radius of curvature may be very great, it is at once apparent that uniformity of elevation and line are so closely associated that one cannot be said to be of more importance than the other. Likewise, gage, surface and line are so inter-related that defects in one are almost certain to affect the others.

Where curves are not lubricated, the maintenance of first-class line and surface will tend to reduce rail wear, since defects in either tend to increase the oscillation of the trucks and wheels, which in turn causes irregular wear. Rail that is not worn uniformly is often worn more than is suspected until the contour is carefully investigated. The necessity for clean ballast and well-drained roadbed is not open to debate, nor is that for sound well-tamped joint ties. Tight bolts, adjusted to the right tension to permit movement of the rail in expansion and contraction, contribute to minimizing rail wear, particularly at the ends of the rail. These items and others that might be mentioned have a definite influence on the rate and amount of the wear that takes place on curves.

Lubricating the wheel flanges and the rail does not change in any way the fundamental requirements for maintaining good track. It merely reduces the rate at which the wear on the rail progresses. This being so, the same track defects that affect rail wear on curves that are not lubricated will influence the wear on those that are, and in the same way, although it may take longer to do so. For these reasons, whether the curve is or is not lubricated, the section forces should follow the same practices in maintaining it that are required to maintain good track elsewhere.

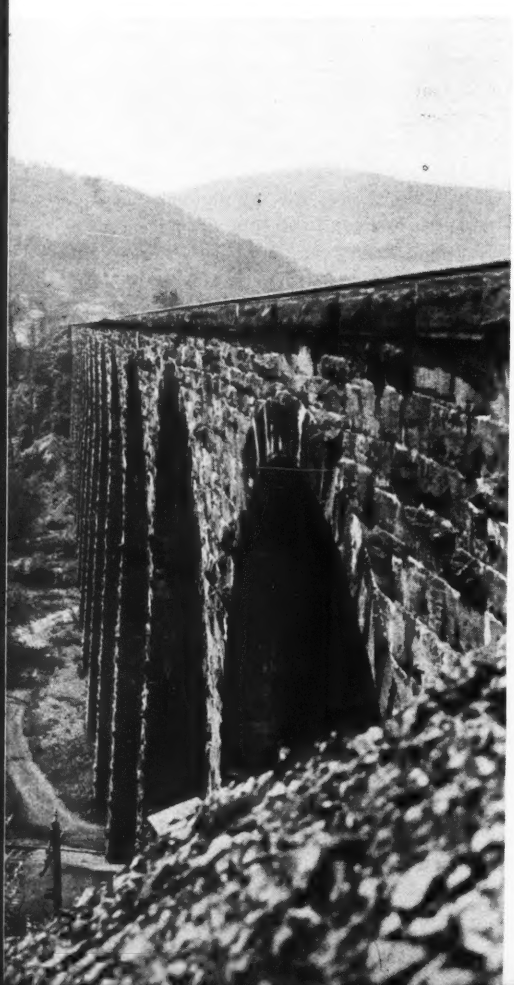
Erie Waterproofs Deck of Historic Masonry Arch

With the strength of its 86-year-old viaduct across the Starrucca Valley threatened by a leaking deck this railroad adopted drastic measures to remedy the situation. The present trouble was encountered following the failure of a system of waterproofing which was applied in 1915.

At Lanesboro, Pa., near Susquehanna, on the Erie, is one of the early marvels of bridge engineering in the United States—the Starrucca Valley viaduct, a multiple-arch stone masonry structure 1200 ft. long and rising to a height of 110 ft. above the valley floor. Constructed in 1848, after two early failures to span the valley, this structure, originally built to carry only a single track and the light railroad equipment of the time, has continued in service through the years and is today carrying two standard gage tracks and the heaviest power on the road.

Equally as striking as the size and strength of this masonry structure is the fact that during its life of 86 years it has required little or no maintenance other than infrequent repointing and repairs to the deck waterproofing. This latter work assumed considerable proportions in 1915 and again last year, it being found at both times that water was percolating into and through the deck structure and causing potential weakness of the structure as a whole. The methods taken to remedy this condition and thus preserve the viaduct for many additional years of service, will be described in this article.

The Starrucca viaduct, with 17 successive arches between high graceful piers, is constructed entirely of an excellent quality of bluestone. The piers, all of which rest on a rock foundation, are of solid cut stone throughout, while the arch rings each consist of a single course of voussoirs, 30 in. deep, backfilled in the haunches between uncoursed ashlar spandrel walls with rubble masonry. The present deck of the viaduct consists of a 15-in. layer of concrete which is pitched from stone parapet walls at the sides toward the center of the structure. At the crown of the different arches, the deck slab rests directly upon the arch rings. The parapets on each side of the viaduct are surmounted by stone copings 15 in. deep and battered on the inside face, which retain the track ballast.



Looking West Along the Viaduct, Which Carries the Erie Main Line Over the Broad Starrucca Valley, 110 Ft. Above the Creek Bed Beneath

The viaduct across Starrucca Valley was urgently required by the Erie to complete the gap in its line between Deposit and Binghamton, N. Y. Unable to find American architects or engineers capable of masonry arch construction of the magnitude required to span the valley, the work was assigned to James O. Kirkwood, a native of Edinburgh, Scotland, who had had considerable experience in masonry arch design and construction. Mr. Kirkwood, with skilled masons imported from his native country specifically for the work and to train the American workmen to be employed, opened up quarries on the sides of the valley above the site of the structure, from which was secured the excellent quality bluestone with which the viaduct was built.

Intended for Single Track and Light Traffic

Intended for a single broad-gage track, the width of the Starrucca viaduct between faces was fixed at 23 ft. 11 in. This was more than generous at the time, but purposely so in an attempt to build strength and stability into the structure and to allow for increases in the weights of equipment and loads. That strength and stability were built into the structure has been demonstrated adequately through the years as the viaduct, without any form of reinforcing, has continued in service under steadily increasing loads. However, whether this strength was appreciated at the time the structure was completed is seriously questioned in view of early records which indicate a high degree of concern on the part of railway men and the public alike, that the viaduct was safe for train operation.

Looking East Over the Deck of the Viaduct—Note How the Tracks Have Been Spread to the Limit to Secure 12-Ft. 4½-In. Centers

That concern was, however, dissipated years ago and the structural integrity of the structure established. Today, double-tracked, an average of 68 trains pass over the viaduct every 24 hours, in many cases with Santa-Fe and Berkshire-type locomotives with as much as 284,000 lb. on the drivers. In fact, it is not uncommon to move two or three of these heavy units over the structure at a time, coupled together in pusher service. There is no speed restriction eastward over the structure, which is on a long 1.15 per cent ascending grade which normally holds speeds down to a maximum of 20 miles an hour, but the speed westward, or down grade, is restricted to 30 miles an hour.

With a clear width of only 19 ft. 10 in. between coping course for tracks, it was impossible to place two tracks on the structure with operating clearance between them, even with the ties moved as far apart as possible, without placing the track rails off center of the ties. This expedient was resorted to, and in the present layout the center line of the east bound track is 7¾ in. outside the centers of its ties, and the center line of the westbound track is 10¾ in. outside the centers of its ties, with the result that a distance of 12 ft. 4½ in. is provided between track centers.

Records indicate that few repairs were made to the viaduct prior to 1914, when, however, extensive leakage was noted through the deck and the joints in the arch rings. Weep holes, two feet square, existed at the crowns of the different arches on the center line of the viaduct, but, in themselves, they were not adequate to drain the deck.

To remedy this condition, it was decided to waterproof the deck thoroughly, single-tracking the structure and removing one track at a time in order to carry out the work. This was done, the first step being to remove one track and then the stone ballast down to the sloping concrete deck slab. Following this, the deck slab was cleaned thoroughly, even to the extent of removing any disintegrated concrete and replacing it with new concrete.

To collect the run-off, a four-inch vitrified tile pipe line was laid longitudinally through the center line of the structure, placed in a groove cut for the purpose. This line was pitched toward the different weep holes at the centers of the arches from high points directly over the piers. Incidentally, short sections of 4-inch cast iron pipe were substituted for the old weep holes. These were concreted in the old openings and were given connection at the top with the drainage line.

With the deck surface thus prepared for the waterproofing, it was first covered with a ¼-in. layer of pitch, and then, to protect the pitch from the cutting action of

Built 86 Years Ago, the Starrucca Valley Viaduct is Still as Sound as it is Architecturally Beautiful

the stone ballast, this was completely covered with ⅞-in. by 2½-in. creosoted pine strips, laid crosswise of the deck, about ¼-in. apart, and extended up the battered faces of the coping walls. When in place, the timber protection course was gone over completely with pitch to fill all joints between the separate pieces, and then a continuous layer of the pitch, ⅛ in. thick, was provided over the top. Following this, the ballast and track were replaced, and the opposite half of the deck was waterproofed in a similar manner.

Re-waterproofing Necessary in 1933

Much to the surprise of the railroad, it was noticed in 1930 that the viaduct deck was again leaking. This was investigated in 1933 and it was found that apparently the pitch employed in the earlier waterproofing had contracted and cracked during cold weather and flowed during hot weather. This was evidenced on the one hand in cracks between the creosoted timber protection strips, and, on the other hand, in the fact that much of the four-inch longitudinal drain tile was actually clogged with a mixture of pitch and dirt.

Having decided to remedy this situation and thus preserve the viaduct, the tracks were again removed from the structure, one at a time, working with cranes and material cars from the adjacent track between trains. After the ballast had been removed, the old pitch waterproofing course, which was found badly fouled with dirt and fine stone, was carefully cleaned off down to the surface of the timber protection course. The protection course, incidentally, was found to be in a perfect state of preservation, with the exception of that against the battered faces of the coping blocks, which, owing to its partial exposure to alternate wet and dry conditions, had deteriorated somewhat. In view of this condition, the protection course over the surface of the deck was not disturbed, except to clean it thoroughly, while the timber protection strips against the back faces of the copings were removed and replaced with asphalt plank.

Cleaning of the protection course was done with pneumatic tie tampers, the bars of which were ground down to a ⅛-in. cutting edge, sufficiently sharp to produce the cutting action desired without injury to the treated timber. Following the cleaning, the deck was covered with a ½-in. course of liquid asphalt, special attention being given to closing and covering any cracks in the old surface. A tight joint between the asphalt plank and the timber protection course over the deck was effected by means of a strip of heavy canvas, thoroughly impregnated and covered with the asphalt waterproofing.

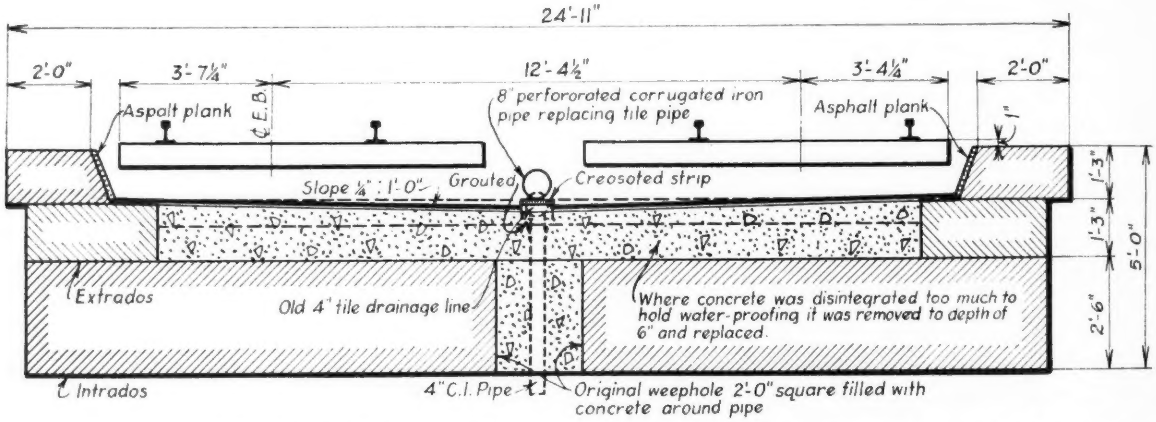
To provide drainage lengthwise of the deck to the old weep holes, replacing the old stopped-up tile line, a new line of 8-in. Armco perforated corrugated iron pipe was laid directly above the old pipe, with the perforations down and with the base of the new pipe level with the top surface of the new asphalt water-proofing course. To lay the pipe in this manner required breaking off the top part of the old pipe where it projected above the surface of the new waterproofing, but no attempt was made to remove the old pipe line as a whole. Under this new arrangement, water collected by the deck drains laterally to the drainage line, into which it percolates through the bottom perforations and is carried to the different old weep holes.

After half of the viaduct deck had been re-waterproofed, clean ballast was placed and the track structure was restored, using the adjacent main track between regularly scheduled trains for the delivery and unloading of materials. Transferring traffic to the side repaired, the opposite side of the deck was then taken out of service and re-waterproofed in a manner similar to that already described. In restoring the track, it was given a 2½-in. raise on additional ballast. This permitted the spreading of the tracks an additional two inches, which was much to be desired in view of the necessarily restricted track centers.

With a force of about 35 men, the work on the eastbound half of the structure was completed in 14 working days, and that on the westbound half in 11 days, the longer time on the eastbound half being occasioned, in part, by the work of laying the new drainage line. In both cases of deck repairs, the viaduct was single tracked by the provision of a No. 15 crossover immediately at each end of the structure. This slowed down train movements past the work somewhat, but at no time was there any interruption of regular movements.

In conjunction with the re-waterproofing of the deck, the different arch rings were gone over carefully and repointed where necessary. All of this work was done from adjustable scaffolds suspended from the deck, and entirely independent of normal train operation.

The recent work of re-waterproofing, which it is expected will be effective for many years, thus prolonging the life of the already historic Starrucca viaduct, was carried out under the general direction of J. C. Patterson, chief engineer maintenance of way of the Erie, and under the immediate direction of I. H. Schram, engineer maintenance of way, Eastern district, and Blair Blowers, division engineer.



Transverse Cross Section of the Viaduct at the Crown of One of the 17 Arches, Showing Revised Deck Drainage and Off-Center Location of the Rails on the Ties

Welding Corroded Rivet Heads

About 2¾ Minutes of Actual Welding Is Required to Build up Each Head

When 150,000 rivets in a large steel viaduct became so badly corroded as to require renewal, the Pennsylvania decided to build them up by welding with the electric arc. As compared with renewing the rivets outright, this method has proved faster and at the same time more economical.

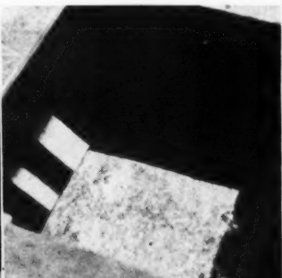
THE Pennsylvania is building up thousands of corroded rivet heads in the deck of a large steel viaduct by electric arc welding, instead of renewing the rivets outright as has been the general practice in the past. In this structure about 150,000 rivets were so badly corroded that they required renewal or the alternative, now being applied, of completely restoring their normal heads by the application of weld metal. To date, about half of the rivets have been built up, the work being done by a small force, which, with two welders, is completing from 275 to 300 rivet heads a day.

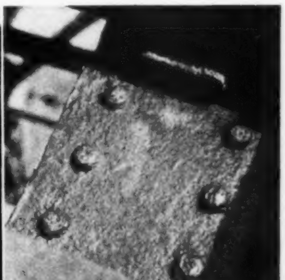
Tests Proved Strength of Welded Heads

The structure involved in the present work is a long steel viaduct in West Philadelphia, which carries the main freight tracks of the road through the city, entirely independent of the passenger tracks and street traffic. This structure, which is about a mile long and carries two tracks, is of the usual steel tower and deck girder type with an open deck, the ties resting directly upon the top flanges of the girders. Subject to heavier wheel loadings and traffic than it was designed to carry when built in 1902, and, likewise, to corrosion during the years, the viaduct has been repaired and strengthened at various times, particularly as regards the deck bracing, girder stiffeners and column footing plates. In 1932, it became evident also that it was necessary or desirable to renew thousands of the rivets in the top flanges of the girders.

Exposed directly to the elements and, more particularly, to the brine drippings from the heavy refrigerator traffic over the structure, many of the rivet heads had wasted away to a fraction of their original size, while still remaining tight and functioning perfectly in shear and bearing. Particularly in view of this latter fact, and a knowledge of the large expense that would be involved in backing out the old rivets and driving new ones, consideration was given to restoring the corroded heads by welding.

Laboratory tests made with a rivet-steel rod similar to that in the rivets of the structure, demonstrated that, in tension, the welded heads were practically as strong as the upset heads, and were more than adequate to meet the requirements of the flange rivets in the viaduct deck structure. This being established, a test organization was formed to ascertain the most economical force to carry out the work, and, during the summer of 1933, the actual work on the viaduct was put on a smooth working basis. Owing to the depressed economic conditions and the further fact that there was no particular reason for speeding the work to completion, the organization employed was not based upon a large production program, but rather on one which would keep the work progressing steadily over a considerable period, while at the same time keep costs to a minimum.





Left—Showing Typical Corroded Condition of the Cover Plates and Rivet Heads. Center—There is Little Left to Many of the Heads When All of the Scale and Rust Has Been Removed. Right—Typical Built-Up Rivet Heads—At Least as Large as Those on Newly Driven Rivets

Welding Operation Is Relatively Simple

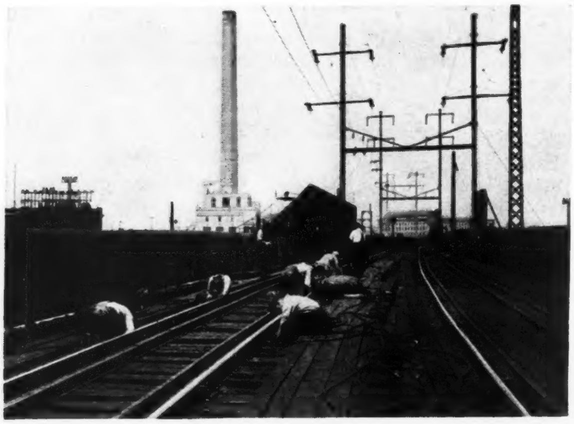
The forming of the weld-metal heads is a relatively simple operation, in which the welder strikes his arc at the perimeter of a normal size head and then, with a circular motion, carries the weld bead inward and upward over what remains of the old head, repeating the operation if necessary to produce a well-shaped hemispher-

ical head. A low carbon, ¼-in. bare rod, 14 in. long is used, and, to avoid any possible misjudgment on the part of the welder as regards the amount of metal added, an entire rod is applied in building up each head, regardless of the varying extent to which the different heads may be corroded away. This occasions the use of excessive rod on certain heads, but, on the other hand,

A Section of the Long, Two-Track Freight Viaduct Where 150,000 Corroded Rivet Heads Are Being Restored by Welding

it removes the possibility of weak heads due to lack of sufficient metal.

The welding current for the viaduct work is furnished by two single-arc, 300-ampere welding generators on flat-tread wheel mountings, which are located beneath the viaduct and moved along as the work progresses. This arrangement keeps the generators clear of trains and, at the same time, always relatively close to the point where the welding is being done.



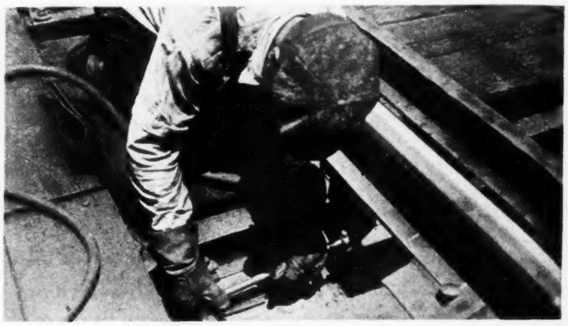
A Crew of Eight Men, Including Two Welders, Build Up From 275 to 300 Rivet Heads a Day

Details of Viaduct Work

In the work on the viaduct, the building up of the rivet heads is being confined almost entirely to those on top cover plates of the girders, it being found that only in exceptional cases are other heads corroded sufficiently to require attention. In carrying out the work, a number of separate operations are involved, restricted in scope and increased somewhat in number by the fact that the top flanges of the girders are stayed against lateral movement by means of steel I-beams placed between the track ties at intervals of about four feet and secured to the top flanges of the girders. This restricts the bunching of the ties to expose the cover plates and rivet heads, and thereby cramps somewhat the cleaning and welding operations.

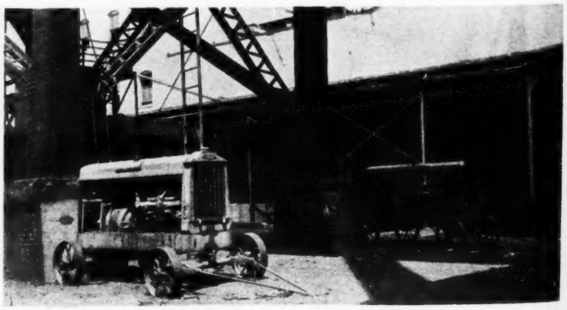
The first operation involved in the repairs is to remove the track guard timbers and then, with two track jacks, to jack up a section of the track about 1½ in., or sufficient to take the weight off from the ties. With the ties suspended, they are then bunched laterally to expose the cover plate rivets and afford as much working space as possible.

Prior to the welding, the entire cover plate, as well as the rivet heads, is cleaned of all rust and scale with chisel bars and pneumatic scaling hammers, the former being used first to remove the heavier material. The scaling hammers are supplied with air from a 2½-in. permanent line extending throughout the length of the viaduct and used principally in the operation of switches and signals. In addition to operating the hammers, the air is also used to advantage in blowing away the scale and rust removed to present a clean surface for the welding and for the repainting of the cover plates.



Pneumatic Scaling Hammers Are Used Principally to Remove the Scale and Rust from the Cover Plates and Rivet Heads

Immediately behind the cleaners, the welders build up the rivet heads in the manner described previously, approximately 2¾ minutes of actual welding time being required to complete each head. Following the welders, a painter gives the entire cover plate a brush coat of red lead, to be followed in a day or two, as most convenient, with a coat of asphalt paint.



The 300-Ampere Welding Generators Which Supply the Welding Current Are Moved Along Beneath the Viaduct

In carrying out the work, the limitations imposed by the tie bars between girders, which permit a maximum working space of only from 18 to 24 in., necessitate considerable shifting of the ties back and forth to permit the cleaning, welding and painting operations. This is a handicap to the progress of the work, but it does not in any way affect its quality. Traffic is permitted over the viaduct without interruption, the abnormally wide

tie spacing occasioned by the work presenting no obstacle to the movement of trains or any possibility of damage to the rail. At the close of the work each night, however, all of the ties are shifted back to their normal positions to preclude the possibility of anyone falling because of irregular tie spacing.

The gang organization being used on the work consists of eight men and a foreman, including two men cleaning, two welders, a painter and a painter's helper, a carpenter helper and a watchman. With this force, an average of from 275 to 300 rivet heads are being built up each eight-hour day worked, the exact number depending to a considerable extent upon traffic conditions.

On the basis of the work already accomplished, the Pennsylvania is satisfied with the structural strength of the welded rivet heads and the entire practicability of the method used on the viaduct. Furthermore, it is estimated that the welding method is effecting a saving of about 25 per cent over the cost of renewal.

The work described is being carried out under the general direction of A. R. Wilson, engineer of bridges and buildings of the Eastern region, and under the immediate supervision of N. M. Lawrence, division engineer of the Philadelphia Terminal division.

Meal Worm Pest Difficult to Eradicate on C. & N. W.

An unusual case of insect infestation, which became a problem because of the general nuisance created rather than because of the extent of the actual harm done, was encountered recently on the Chicago & North Western. So hardy and numerous were the insects involved that they resisted many efforts of the railroad to eradicate them, and finally succumbed only after the most drastic measures had been resorted to.

The scene of the infestation was a dock house of wood construction located on the bank of the Milwaukee river at Milwaukee, Wis. This dock house, which is of irregular shape with a floor area of about 90,000 sq. ft., is used principally as a transfer warehouse for the movement of merchandise shipments from railroad cars to lake boats in the river, this merchandise consisting in large part of grain and food products. The floor of the warehouse is constructed of 3-in. planks laid on 6-in. by 8-in. sleepers imbedded in locomotive cinders.

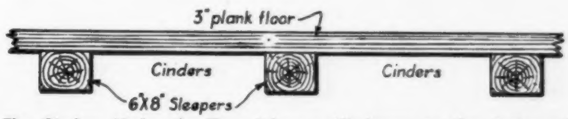
First Noted in 1931

About 1931 the presence of meal worms in the structure in considerable numbers was first noticed. These worms were identified as being of two types, Tenebrio molitor and Tenebrio obscurus, both being of approximately the same size and having the same feeding habits, differing materially only in their coloring. In their life cycle these worms pass from the egg to the larva and thence to the pupa, finally reaching the adult stage in the form of beetles. When in the form of larvae, in which stage they are about 1 in. to 1¼ in. in length, they are most active and are voracious eaters, feeding on meals and flours of all kinds, bran, refuse grain, coarse cereals, bread, crackers, and all foods of similar nature.

The dock house at Milwaukee seemed to provide almost ideal conditions for the development and propagation of these worms. During the day they remained in their nests beneath the floor planks, coming forth at night through the cracks in the floor to feed on such grain and other material as may have sifted from cloth bags and other containers. While the worms did not actually destroy or damage containers to obtain food, they became so numerous that their eradication became highly desirable because of santitary and other considerations.

Live Steam Used Without Result

In the beginning various insecticides were resorted to without appreciable affect on the worms. Following the failure of these measures various other expedients were attempted without success. One of these, carried out in 1932, involved the injection of live steam into the cracks in the floor. This attempt, which was inspired by the knowledge that these worms cannot survive temperatures higher than 125 deg. F., proved ineffective because the presence of the cinders prevented the hot steam from reaching the nests which were located directly underneath the planks and adjacent to the sleepers. The next remedy applied was a fumigant in powder form which was injected through holes drilled in the floor planks. On exposure to the air this powder forms a highly poisonous gas. However, it was only partially effective in destroying the meal worms owing to the resistance presented to the spread of the gas by the closely-packed cinders.



The Cinders Under the Floor Were a Hindrance to the Action of Insecticides

By 1933 the situation had reached an aggravated stage and, despite the various measures that had been undertaken, the number of worms present remained undepleted. It was recognized, therefore, that more drastic action had to be resorted to if the worms were to be destroyed. One of the measures given consideration at this time was the complete sealing of the floor either by the application of an asphaltic wearing surface or by constructing an entirely new floor. These plans, however, were rejected because of the cost involved.

Previous experience had indicated that the action of fumigants and insecticides was definitely retarded by the presence of the cinders under the planks. It was decided, therefore, to take up the floor, spray the exposed worms with a powerful insecticide, and remove the cinders together with the dead worms to a depth of three to four inches below the bottom of the floor, before replacing the planks. The insecticide used consisted of a mixture of 2/3 kerosene and 1/3 turpentine, which was applied by means of small spray guns of the type ordinarily used for the application of insecticides.

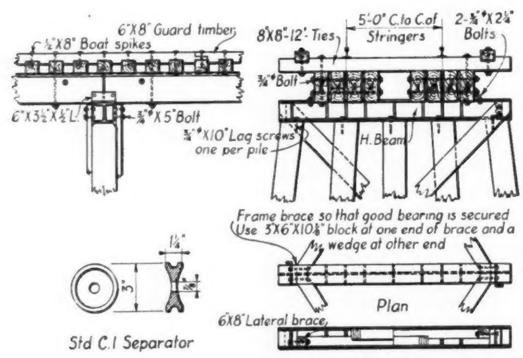
This method, which was carried out at a moderate cost, proved entirely effective in ridding the dock house of the worms and up to the present no recurrence of them has become evident. In the event that there is a revival of the worms it is felt that, owing to the open space beneath the floor formed by the removal of the cinders, the proper insecticide or fumigant when injected beneath the floor will be effective in killing them. With this possibility in mind the railroad has drilled a row of one-inch holes along the middle of each plank to facilitate the injection of a fumigant should this become necessary. However, subsequent periodical inspections have indicated that the building has remained free of these pests.

The work of destroying the meal worms was carried out under the joint direction of H. D. Browne engineer of tests of the Chicago & North Western, and A. M. Rieck, supervisor freight claim prevention.

Uses Steel Cap in Wood Pile Trestles

THE use of 12-in. steel beams for the caps on the bents is the outstanding innovation in the new standard plan for open-deck pile trestles of the Northern Pacific. Unlike most railways that have recently evolved new designs for their pile trestles for the purpose of improving practice in the use of treated wood, the Northern Pacific's new plan is intended for trestles of untreated Douglas fir, which are standard on that road. However, in common with other roads, the Northern Pacific has found that the cap comprises the most troublesome element of trestle structure, for it is subject to more rapid deterioration than any of the other main members and its replacement is not only more expensive but also entails operations than can easily lead to damage to the other members. Considerations leading to the adoption of a steel cap include its greater strength, especially in bearing, the elimination of deterioration due to decay, and the opportunity afforded for the development of improved connections to the piles and the stringers.

The steel cap of the Northern Pacific trestle is a 12-in. 65-lb. CB-section beam, which has a 12-in. flange width, the web and flanges being 0.4 in. and 0.608 in. thick, respectively. This is strengthened by the introduction of



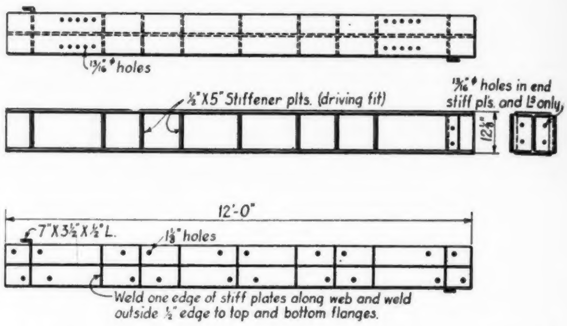
Typical Details of the New Standard Open Deck Trestle of the Northern Pacific—Plan and Elevation in Lower Right Corner Indicate Method of Framing Lateral Braces

bearing stiffeners on each side of the web, which are so placed that there is a pair of them over every pile and three pair under each stringer chord. These stiffeners are made of ½-in. plates cut to fit and welded to both the web and the flanges, except that a stiffener on one side at one end and another on the opposite side at the other end are 7-in. by 3½-in. by ½-in. angles, similarly attached, which serve as the means of fastening the upper ends of the sway bracing to the cap.

The plan calls for five-pile bents, each pile being attached to the cap by a ¾-in. by 10-in. lag screw, driven into a ⅝-in. hole drilled in the top of the pile. To allow for normal variations in the position of the piles, four 1⅛-in. holes are provided in the bottom flange of the steel cap for each pile, thus affording an adequate choice of holes for the lag screws.

The stringer chords are secured to the caps by means of 6-in. by 3½-in. by ½-in. angles 15 in. long, placed against the outside stringers over the caps, with the long leg vertical, and bolted to the chord by means of two ¾-in. chord bolts and to the cap by means of two ¾-in. by 2½-in. bolts. To allow sufficient lateral variation in the position of the chords on the cap, where the trestle is on a curve, five pairs of 13/16-in. holes, spaced 2½-in. center to center, have been provided in the top flanges of the cap for the two chord connections.

The Northern Pacific has adhered for many years to a 15-ft. spacing of bents, increasing the size and number of stringers when required by the increasing weight of locomotives and cars, so that the present standard plan calls for four 9-in. by 18-in. stringers in each chord. The stringers are all 30 ft. long except alternate stringers in the end panels, which are in half lengths to break the



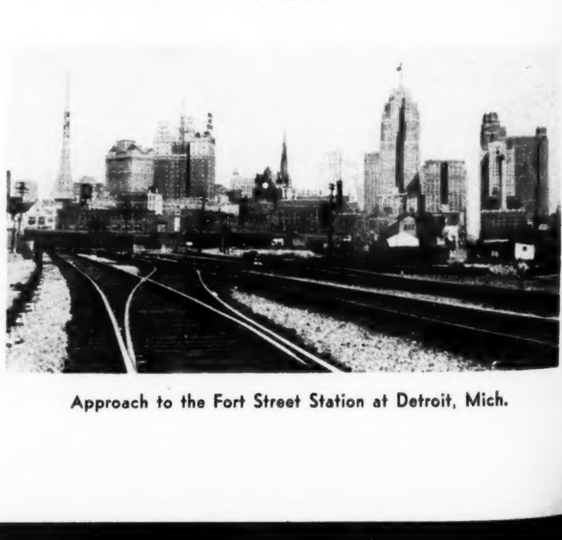
The 12-in. CB-Section Caps Are Provided with Stiffeners Welded to the Web and Flanges

butt joints over the intermediate bents. Cast iron separators on the chord bolts provide air spaces 1¼ in. wide between the stringers making up the chords. The chords are covered with 24-gage galvanized iron, except where the entire deck is covered with a galvanized iron protection.

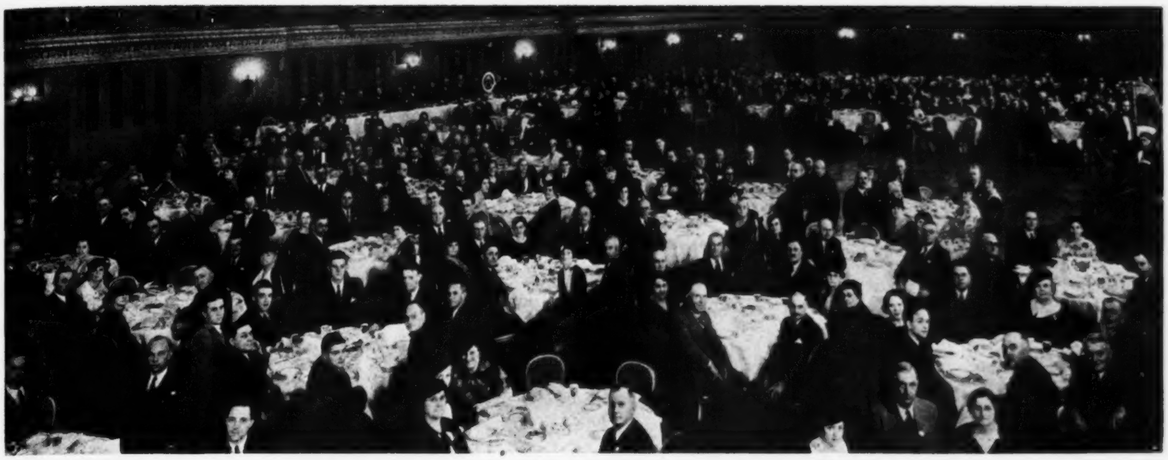
The ties are 8-in. by 8-in. by 12-ft., spaced 15 in. center to center, every fourth one being bolted to the outside stringer with a ⅝-in. deck anchor bolt. The timber guard rail, 6 in. by 8 in., is dapped 1½ in. over the ties, to which it is secured by ½-in. by 8-in. boat spikes, except in the ties on each side of the guard-rail splices where ¾-in. bolts are used.

The sway bracing of bents and the longitudinal bracing, where provided, conform to usual practice, but the plan provides for lateral bracing in the plane of the caps on sharp curves or in other locations where it is difficult to maintain the alinement. This consists of crossed diagonals of 6-in. by 8-in. pieces, bearing at the ends in the corners formed by the webs of the steel caps and the end stiffeners. Blocking or wedges are introduced between the end stiffeners and the ends of the diagonals to insure a tight fit.

We are indebted for the above information to M. F. Clements, engineer of bridges of the Northern Pacific, St. Paul, Minn.



Approach to the Fort Street Station at Detroit, Mich.



The Dinner Was Attended by 425 Members and Guests of the Roadmasters' and Track Supply Associations

Roadmasters Hold Convention

The First in Four Years

Attendance at the three days meeting in Chicago on September 18-20 was exceeded only once in the history of the association

THE success which attended every phase of the forty-ninth convention of the Roadmasters' and Maintenance of Way Association, that was held at the Stevens hotel, Chicago, on September 18-20, is ample evidence of the complete recovery of that organization to full vitality after an enforced idleness during the four years since its last convention in 1930. The attendance, as measured by a registration of 309 members and guests, was greater than at any previous meeting except that in 1929; unflagging interest was maintained in the program throughout the five sessions; the various reports and papers were actively discussed from the floor; and the exhibits of track materials and equipment presented by the Track Supply Association in booths adjoining the convention hall were carefully inspected by those in attendance. In a word, the convention was a convincing demonstration that the members appreciated keenly the opportunity afforded them to resume their annual meetings. The circumstances responsible for the postponement of the conventions in three succeeding years and steps taken to hold a convention this year were reviewed in the address of President Elmer T. Howson, editor of *Railway Engineering and Maintenance*, which is abstracted on another page.

An Excellent Program

The program measured up to the high standard set in previous years. In addition to an address of welcome by Harry G. Taylor, chairman of the Western Association of Railway Executives, it included committee reports on Spot Versus Group Renewal of Cross Ties, Roadbed Embankment Maintenance, Methods of Cleaning Stone Ballast, the Conservation of Rail, and Highway Crossing Construction. In addition, papers were presented by J. E. Long, superintendent of safety, Delaware & Hudson on The Next Goal in Safety; by A. N. Reece, chief engineer of the Kansas City Southern, on Building a Maintenance Organization; by Earl Stimson, chief engineer maintenance, Baltimore & Ohio, on Meeting Present Day Roadway Requirements; and by Robert Faries, assistant chief engineer-maintenance of the Pennsylvania on The Extent to Which a Railway is Warranted in Making Capital Expenditures for Permanent Track Construction to Effect Economies in Repair and Maintenance. All of these are published in following pages, except the papers by Mr. Reece and Mr. Stimson, which will appear in the November issue.

As in previous years, the Roadmasters and their families were the guests of the Track Supply Association at a banquet on Wednesday evening of the convention week, the formal program being confined to short addresses by D. J. Higgins, president of the Track Supply Association and President Howson.

Greetings from the American Railway Engineering Association were offered at the opening session by R. H. Ford, first vice-president (assistant chief engineer of the Chicago, Rock Island & Pacific), who paid a tribute to the accomplishments of the officers of track maintenance in the face of decreased appropriations, curtailed labor and material allotments during the last five years, and a concurrent speeding up of train movements. He also directed attention to the many portents of an impending revolution in railway transportation, with an attending expansion in the responsibilities and opportunities of the engineers and others responsible for tracks and structures.

In a similar capacity, C. S. Heritage, bridge engineer of the Kansas City Southern, extended the good wishes of the American Railway Bridge and Building Association, of which he is president. He emphasized the community of the interest of the two organizations.

In the election of officers C. W. Baldridge, assistant engineer, Atchison, Topeka & Santa Fe, Chicago, was advanced from first vice-president to president; J. J. Desmond, division engineer, Illinois Central, Chicago, was advanced from second vice-president to first vice-president; and Armstrong Chinn, chief engineer of the Alton, Chicago, was elected second vice-president. T. F. Donahoe, supervisor of road, Baltimore & Ohio, Pittsburgh, Pa., and James Sweeney, treasurer, supervisor (retired) of the Chicago & Eastern Illinois, Danville, Ill., were re-elected secretary and treasurer, respectively. J. J. Davis, roadmaster, Elgin, Joliet & Eastern, Joliet, Ill.; W. O. Frame, district engineer maintenance of way, Chicago, Burlington & Quincy, Burlington, Ia., and F. B. Lafluer, roadmaster, Southern Pacific Lines, Lafayette, La., were elected members of the executive committee.

Chicago was selected unanimously as the place of the next convention, and the following topics were submitted to the executive committee as subjects for reports to be presented at the next convention:

Recent Developments in the Organization of Track Forces.

The Distribution and Handling of Ties from the Treating Plant or Storage Yard to the Point of Use.

The Maintenance of Tracks in Terminals—Organization, Materials and Methods.

Ballasting and Resurfacing Track—Equipment, Organization and Methods.

The Maintenance Reclamation and Repair of Frogs, Switches, Railroad Crossings and Other Track Material and the Economic Limitations of Such Practice.

President Howson's Address

THE Roadmasters' Association was organized in 1882. It antedates, therefore, all other associations in the maintenance of way field. Indeed, there are few older in the entire railway industry. It met in annual convention every year without a single break until 1931, the convention in 1930 being the forty-eighth consecutive annual meeting. Even during the critical years of the World War, our organization was one of the few in the railway field whose continued activity was approved by the federal railroad administration as contributing to the winning of the conflict.

Elmer T. Howson
President
Mr. Howson is editor of Railway Engineering and Maintenance, and western editor of Railway Age

In 1931, however, a new condition arose. Confronted by the most drastic declines in earnings, and, even more serious, by the inability to see what was ahead, the railways were forced to the most heroic measures. Disregarding the future, they were forced to concentrate on the problems of the day alone. In this spirit, they called on all of the voluntary railway associations to suspend activities. Our association received this request and complied with it. Again in 1932 and 1933, your officers met to review the conditions and decided to suspend our conventions.

Last spring, when it appeared that the clouds were beginning to lift, your officers joined with officers of the American Association of Railroad Superintendents and the American Railway Bridge and Building Association in presenting to the Western Association of Railway Executives a statement of the work of these three organizations and the importance of the resumption of this work to the solution of those new problems that are arising in railway operation. This statement was graciously received and after due consideration, we were advised that the executives approved the holding of our conventions, and the member roads were so advised.

Work Was Not Suspended

While the formal conventions were cancelled, the work of the association was by no means suspended. When it was decided by the executive committee on August 20, 1931, to eliminate the convention for that year, it was decided also to ask all committees to carry their reports over and to amplify them with such further information as could be collected in the additional time given them. Also, two new committees were appointed to prepare reports on topics of special timeliness. Then, in 1933, when it became evident that no convention should be held that year, the offer of *Railway Engineering and Maintenance* to publish these reports in a special "Convention in Print" issue, and thereby make available to our members and to the railways the practical and valuable information incorporated in these reports, was accepted. Shortly thereafter, new subjects were selected and new committees appointed, whose reports are presented at this convention.

Through the collection of delinquent dues during the early portion of our period of inactivity, we have been able to carry on all activities with a reduction in assets of only $1200. Furthermore, we have in the treasury today nearly $4,000, a tribute to the wise administration of the association's funds by your officers of past years. By reason of our reduced activities and made possible by the surplus in our treasury, your officers voted to cancel all dues during the years 1932, 1933 and 1934, for all members whose dues were paid through 1931.

Turning to the broader phases of that branch of railway operation for which we are so directly responsible,

we face at once the fact that this is a day of rapid change. The completion within the present year of the first streamline, high-speed passenger trains, by the Union Pacific and the Chicago, Burlington & Quincy, marks the beginning of a new era in railway transportation in this country. Already the advent of these trains has been followed by orders for others by these same roads and by a half dozen other roads as well. As a result, before we meet in convention next year, trains will be operating at speeds approaching 100 miles an hour on railways in New England and on the Pacific Coast and numerous areas intermediate.

This development creates new problems for the track man, not perhaps so much in the strengthening of the track structure as in the refinement of line and surface. On one road where trains of this type are to be placed in service in the near future, some 35 extra gangs are now at work within a distance of 400 miles, converting a 60-mile-per-hour line into one good for 100 miles per hour. Nor is the change in traffic conditions confined to passenger service, for the same trend is equally evident in freight operation. Hours and days have been cut off schedules, and tonnage trains are being run at passenger-train speeds. This again changes the problem confronting the track man.

Coincident with this demand for more exacting maintenance is that for greater economy in the conduct of work in the face of competition offering cheaper service. If the railways are to meet this competition, they must reduce all costs to the minimum, and the maintenance man must do his part. One way in which he is reducing his costs is through the use of machinery. He has already made much progress in this direction. Yet he has in reality only made a beginning. He must go much further, improving the equipment now available and devising equipment for tasks as yet done by hand. In like manner, he must further improve the hand tools which he now uses and will always need by the use of better materials and alloys, by heat treatment, etc., in order that the return per dollar expended may be increased.

Closely allied with the use of more and better equipment is the trend towards specialized gangs, each provided with equipment which will aid it in its particular task and manned with labor that becomes most proficient in the one operation. Rail has long been relaid by such gangs. Ballast has likewise been so applied. Since the last convention, however, a few roads have transferred to such gangs the renewal of ties, and the development of mechanical bolt tighteners have caused certain roads likewise to transfer this work to special forces. By such measures the section gang, which has long been the backbone of the maintenance of way organization, is becoming more of a first-aid force, doing those tasks that arise daily and leaving the heavier tasks to be carried out by the specialized gangs.

C. W. Baldridge
First Vice-President

J. J. Desmond
Second Vice-President

Roadmasters' Association

Officers 1931-1934

Elmer T. Howson, President, Editor *Railway Engineering and Maintenance,* Chicago.

C. W. Baldridge, First Vice-President, Assistant Engineer, A. T. & S. F., Chicago.

J. J. Desmond, Second Vice-President, Division Engineer, Illinois Central, Chicago.

T. F. Donahoe, Secretary, Supervisor of Road, B. & O., Pittsburgh, Pa.

James Sweeney, Treasurer, Supervisor (Retired) C. & E. I., Danville, Ill.

Executive Committee

Earl E. Crowley, Past President, Roadmaster, D. & H., Oneonta, N. Y.

(Terms Expire September, 1937)

B. Esbenson, General Roadmaster, Union Pacific, Los Angeles & Salt Lake Unit, Salt Lake City, Utah.

W. H. Sparks, General Inspector of Track, Chesapeake & Ohio, Huntington, W. Va.

(Terms Expire September, 1936)

A. Chinn, Chief Engineer, Alton, Chicago.

G. T. Donahue, Supervisor of Track, New York Central, Richland, N. Y.

(Terms Expire September, 1935)

A. A. Johnson, Engineer Maintenance of Way, D. L. & W., Hoboken, N. J.

P. J. McAndrews, Roadmaster, C. & N. W., Sterling, Ill.

(Terms Expire September, 1934)

E. A. Buhrer, Supervisor, N. Y. C. Ohio Central Lines, Kenton, Ohio.

M. Donahoe, Division Engineer, Alton, Bloomington, Ill.

T. F. Donahoe
Secretary

James Sweeney
Treasurer

There is still another phase of the equipment problem which is pressing for attention but to which railway men as a whole have as yet given little consideration. This is the replacement of obsolete equipment with that which is more modern and efficient. Until recently, railway maintenance officers have been so engrossed with the problems of securing enough equipment for their various gangs that they gave no thought to the retirement of the less efficient units. Within the last three or four years, however, the number of gangs has been so reduced that there is ample equipment, if not a surplus of many types.

This does not mean, however, that the equipment needs have been met, even with respect to this particular type of equipment. The development of much of this equipment has been rapid and later units frequently show vastly greater efficiency than their predecessors. Also, conditions of use on the railways are constantly changing and these changes affect the equipment. Take the motor car as an illustration. Obviously, the motor car that was designed for the six-man gang of five years ago is too heavy to be handled comfortably and safely by the three-man gang of today. So it is with much other equipment which is being made obsolete by changing conditions more rapidly than is generally appreciated.

Conservation of Materials

Another lesson that we are learning since we last met is the more complete conservation of materials. The possibilities of extending the life of track materials by restoring the contour of worn surfaces by welding metal thereon, first developed with frogs and crossings, has extended to battered rail ends and to joint bars where it is rapidly becoming standard practice. With another recent development, the heat treatment of rail ends, it is rapidly bringing the life of the rail and fastenings to that of the treated ties, suggesting the possibility ultimately of renewing the entire track as a unit, as is done on some of the highly maintained European railways, rather than piecemeal as we now do here.

The Future of the American Railways

By HARRY G. TAYLOR

Chairman, Western Association of Railway Executives, Chicago

Harry G. Taylor

I WISH to express upon the behalf of the managements the obligation which the railroads of this country owe to you men who have performed what I regard as a remarkable service particularly during the past five years. When I scanned some of the statistics on railroad maintenance, I was amazed. I discovered, for example, in 1929 the railroads of the United States expended a total of more than $855,000,000 for maintenance of roadway and structures, and that in 1933 that figure had dropped to only $322,000,000, or a little over one-third of the expenditures for 1929. In 1929 we employed 411,000 men in the maintenance of roadway and structures, and in 1933 the number had dropped to 198,000.

It is presumptuous of me to attempt to interpret those figures to you who have been out on the firing line and who appreciate the full significance of the catastrophe represented by these figures. There have been many discouraging periods during the last five years, many disheartening events, that have led you to wonder, with a skeleton force and skimped materials and unrelenting pressure to save expense and cut costs wherever possible, whether or not you would be able to carry on. But I am glad to be able to say that you have carried on. In my opinion, the record of the last five years, insofar as your relation to it is concerned, will go down in railroad history.

Despite this skimped maintenance year after year, the trains have been running and they have continued to run on schedule and with a minimum of accidents and troubles of that nature. It is a most amazing record. And this has been done in the face of constantly increasing demands for speed, all of which increase the responsibility of the men whose duty it is to maintain the track upon which these trains run. Your accomplishment in the face of the obstacles due to the skimped and restricted things with which you had to work, and in the face of the continued demand for better and more exacting service is an amazing performance.

I wonder, when you were building these roadways and these structures five or six years ago, if you really knew that you could operate as you have operated for this period of five years with an expenditure for maintenance in both men and materials so far below what we regarded as the normal requirements as to have seemed utterly impossible and incredible a few years ago? And yet that has been done. And it is testimony to the thoroughness, completeness, skill and permanence with which you men have done your job.

Every transportation agency today is attempting to increase the speed of its operations. So we ourselves, in this competition of agencies, must expect to meet that demand on the part of the public for increased speed. And we will have to be careful that our traditions as railroad men, glorious and inspiring as many of them are, do not become prejudiced as to blind us to the new tasks and the new thinking which we will be called upon to exercise now and for the next few years. If we have been building tracks for a maximum speed of 60 miles an hour, we will now have to lift our sights and build tracks for a maximum speed of at least 100 miles an hour, and perhaps more.

Demand for Lower Operating Costs

Also, we are facing as we never faced in this country before the demands for lower costs of operation. In the new forms of competition which press upon the railroads from every side, there is a necessity on our part for reducing our costs so that we are sure that we can operate on a comparable basis and probably at a lower basis than any of our competitors. And as we seek out the ways by which that can be done, our minds must be plastic. We

will profit, of course, by the experience of the past, but we will be thinking in new terms and with new ideas and a challenge of new obligations which will make it necessary for every man to maintain an attitude of willingness to adjust himself to the new conditions. This depression, of course, has had its lessons. It has been a bitter experience. And yet out of it are certain to come many lessons of value to all of us.

There also confronts you particularly the introduction of new machinery. That is one of the next steps—partially taken, of course, because we have introduced much of machinery in the operation of the railroads—but we are certain to find the demand for more of it as we approach this problem of cost and speed, and the introduction of machinery will probably call for a readjustment of organization and the realinement of our setup for doing these jobs.

As to the Future

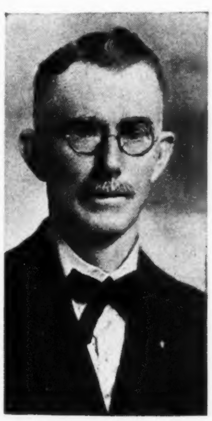
I want to impress upon you that railroading today has become a national enterprise. And as employees and as officers of individual railroads, you are a part of this national enterprise. Whether you will or not, you cannot divest yourselves of the responsibility which is attached to that larger and broader viewpoint. The 250,000 miles of railroads in the United States have knit this continent into a unit such as exists nowhere else on this globe. We are operating on a scale that is duplicated nowhere else in the world. And we have succeeded in doing it, because we as American citizens have developed a breadth of view, a tolerance of opinion and a willingness to work with the other fellow. I still insist that to be a railroad man is to occupy as desirable a position as exists in any other industry. I refuse to listen to the man who tells me that the railroads have no future because I am firmly convinced that they have.

Railroads to Remain in Picture

We ought to remember that the constructive genius of mankind cannot be plotted on a chart or measured by statistics. The things accomplished in the making of railroads of the United States are the best proof of that fact. Men defied the impossible. They rejected the statement that the thing couldn't be done. They risked colossal failure and yet made it a success. Yes, I believe as firmly as I ever believed anything that the railroads of the United States still have a place in the industrial and commercial picture of this great United States of ours, and that you and I who may be spared to participate in that place will be able if we carry on to share in the glory which these men about whom I have spoken just now established for us.

Roadbed Embankment Maintenance

Report of Committee



J. P. Corcoran
Chairman

THE maintenance of track to the desired standard of line and surface is influenced to a large extent by the stability of the roadbed. This report is concerned with the defects in embankments that cause instability of the roadbed, and reviews the various measures that can be applied to correct them.

A number of defects may be mentioned. The top of the embankment, (the roadbed) may be too narrow, because it was constructed too narrow in the first place, or because of the sliding or sloughing of the slopes. The embankment may be unstable for various reasons, such as its construction over a peat bog or other soft foundation or on sloping strata of slippery material, because of the use of unstable fill material, or because of construction or maintenance methods that have resulted in the formation of water pockets. It may also be subject to erosion by reason of inadequate means of disposing of the rainwater falling on the roadbed, or because of inadequate protection of the toe of the slopes from adjacent waterways.

The primary reason why many embankments are too narrow is because they were built for loads much lighter than those they must carry today. Evidence of the need for greater roadbed widths is shown by the progressive increase in the standard widths specified by the American Railway Engineering Association, since its organization a third of a century ago. It is shown also by the fact that many old embankments that have been stable for years, have later become subject to water pockets and sliding slopes. Roadbeds become narrow also as the result of the sloughing or erosion of the slopes, which are discussed under other headings.

The subgrade must support not only the track and the ballast, but also the weight of the cars and locomotives which are applied to it with a considerable impact. Inability to do this arises from three primary causes; the shrinkage of the material from which it is formed, the spreading of the embankment to the sides, and the subsidence of the ground surface on which it is supported. The first two of these conditions are influenced by the material used in construction, and the last one by the nature of the ground on which the embankment is built.

Unstable Material

Since the early days of railroad construction, embankments have been built with material that was available at the least expenditure, and has ordinarily been taken from adjacent cuts or the most convenient borrow pits. The matter of suitability of this material for the formation of a stable fill has rarely resulted in the discarding of the least expensive material for better material available at greater expense. Frequently, clays or other materials that become exceedingly soft and slippery when wet have been introduced into embankments, with the result that the embankments are soft, the slopes are subject to sliding, and the roadbed is prone to the formation of water pockets. The conditions have been aggravated by the dumping of material from filling trestles, leading to the formation of inclined cleavage planes, although this condition is less prevalent in newer construction, in which material has been placed by motor trucks or tractors which consolidate the fill as they run over it. However,

maintenance officers are concerned more largely with the great majority of the fills which were constructed by dumping from trestles. In general, maintenance expenditures have been increased by reason of the effort to reduce construction costs to a minimum.

Soft foundations are encountered most frequently where a line crosses peat bogs, or occasionally where it is built over ground that had previously been filled. The cure of these conditions is ordinarily considered a construction problem.

Sliding Embankments

The primary cause of the sliding of embankments is the use of unstable material in their construction. Certain clays and soils do not solidify readily, and become exceedingly soft when wet. Consequently, the vibrations of passing trains have a tendency to cause the material to slide or slough down the slopes. In general, the sliding of embankments results from the accumulation of water in the material from which they are formed. In some cases, slides are caused by the softening of the toes of slopes because of the presence of undrained borrow pits or ditches too close to the foot of the embankments or the construction of the fills across swamps. However, in most cases, the water enters the fill through water pockets in the roadbed, a condition which will be discussed in greater detail later.

Slides result also from the construction of an embankment with slopes at a greater pitch than the angle of repose of the material from which it is constructed. In such cases, the material will slide until it reaches its natural slope. In other cases slides take place where the sides have been filled out to widen the roadbed or where subsequent provision has been made for second track. Cleavage planes develop between the new fill and the slope of the original embankment that produce a marked tendency to the formation of slides. Serious troubles from this cause can be avoided by stepping or terracing the slope before new fill material is placed.

Slides occur also where a fill is placed on ground that

This Slide Occurred During Construction

lies on too steep a slope, or where it is constructed over sloping strata of shales or clays which are slippery when wet. Upon the penetration of water between such strata, the co-efficient of friction of the cleavage planes is markedly reduced and sliding results. These cases are rare, but when they are encountered, they are usually serious, as the effect is that of moving the entire embankment down the slope.

Slides are sometimes caused also by the entrance of water into the bottom of an embankment from springs in the slope of the ground below the end of a cut or from subsurface water entering the base of a fill near the end of a cut. Slides are among the most hazardous of the defects in embankments, as they sometimes take place when least expected, and large masses of material break away suddenly. As many as 30 to 40 carloads of material must sometimes be placed to fill up a slide or break in the side of an embankment.

Erosion

Erosion, or the washing of the slopes of embankments, may be brought about by any number of conditions. For example, the hoeing of weeds, the cleaning of ballast, or the removal of dirt from the shoulders of a roadbed sometimes leads to the formation of a depression between the toe of the ballast and the shoulder of the embankment, which collects water during heavy rains and this accumulates until it finds an outlet through the shoulder and flows down the slope, thereby causing a wash or gully to form. However, a more potent source of erosion is found where the roadbed is built along a side hill adjacent to a water course, which may be dry for most of the year but which becomes a swiftly running stream in the spring and following heavy rains. Unless this condition is watched, it can easily result in the washing out of the foot of the embankment, with a subsequent sliding of the slope above.

Erosion frequently occurs also where insufficient precautions have been taken to provide diversion ditches to

A Water Pocket

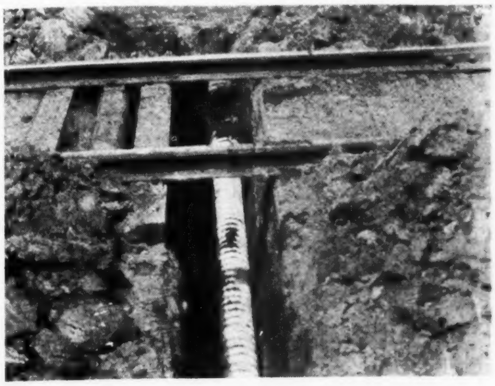
carry the water from the side ditches of cuts away from the toes of the adjacent embankments. Erosion, like slides, is a source of hazard because it may take place very rapidly and produce washouts.

Water Pockets

Water pockets have existed since the construction of the first railways. They may be the product of either natural or artificial conditions; yet they are able to persist only through failure to provide proper and adequate drainage. They are found in both cuts and embankments. Those which are the product of natural conditions result from water reaching and being held in the soil by capillary attraction. Those resulting from artificial conditions generally contain free water which is retained because of improper, or complete lack of, drainage.

Water pockets are formed in various ways. They may be due to the use of unstable material in embankments, or to failure to remove such material from the subgrade

in cuts; to the placing of frozen material in winter, to an excess of timber from filling trestles, which later decays and leaves cavities for the reception and retention of water. Too often the subgrade is not allowed to settle properly before it is used. The operation of trains over an unseasoned roadbed without ballast of the proper quality or depth, tends to form depressions in the surface of the roadbed, which are quite certain later to develop into water pockets. They are formed also when rock or



Tapping a Water Pocket with a Lateral Drain

other coarse ballast is placed on an unseasoned fill, with the result that the ballast is forced down into the soft fill material.

Water pockets are often formed in an old roadbed that has previously been free from this trouble, by the construction of a new subgrade of impervious or impenetrable material at a higher elevation alongside existing tracks. Likewise water pockets are likely to occur at any point where an insufficient depth of ballast is being maintained or where other conditions permit the entrapment and retention of water in the roadbed.

Correcting Defective Embankments

Narrow embankments should be widened, an operation that can be carried on economically in connection with the widening and ditching of cuts. However, it is necessary to observe certain precautions in the conduct of this work to avoid the development of conditions that will lead to some of the defects that have been discussed above. Stepping the old embankment slopes, previously mentioned, is a preliminary measure of great importance if the filling material is of a nature that is prone to sliding. If the material from cuts or ditches is of an especially unstable character, it is better to waste it than to attempt its use in the embankments.

It is especially important to avoid conditions that would lead to the formation or aggravation of water pockets. If the fill material to be used is shale, clay or clay soil, none of it should be allowed to remain at an elevation higher than the shoulder of the existing roadbed or higher than the bottom of any existing water pockets, since otherwise the new fill will form a dam along each side of the roadbed that will prevent rain water falling on the roadbed from draining away. Sand, gravel or other porous material should be used to top off the material applied for widening the roadbed. In widening embankments, the committee is of the opinion that instead of placing the material in layers as had been advocated by some, it should be placed by unloading from cars and pushed down the slope by a spreader.

Embankments that have settled require raising as well as widening and in this case, also, it is of utmost importance to conduct the work in such a way that porous material under the tracks is not enclosed between dams of impervious material along the shoulders.

Where the tracks have settled because of subsidence of the foundation on which the fill was built, it may be necessary in some cases to continue the filling process until the embankment has subsided far enough to press out the entire bed of peat or other soft material. In other cases, it may be possible to stop the subsidence by counterbalancing the weight of the fill by means of large heavy berms extending out from each side of the roadway embankment.

Whenever a new fill is constructed or an old one is raised so as to require new ballast, soft ballast such as cinders or fine pit run gravel should be used until the roadbed has thoroughly settled, the time required for this varying widely with the character of the material used, and the volume of traffic, as well as the climatic conditions. No hard ballast should be applied until after the settlement is complete, since otherwise the coarse ballast will press down and mix with the soft material underneath and create a condition that is sure to lead to the formation of water pockets.

Erosion of the slopes can be cured by providing protection against wash. If the slopes are being eroded by water running off the roadbed, special attention should be given to the development of a heavy sod by the growth of suitable grasses or vines, and in severe cases on high fills it may be necessary to plant fast growing shrubs or even willows. Such plants should be started at the bottom of the slope and progress toward the top so that the roots will become matted and hold the slope. Such shrubs should be cut from 12 to 15 inches high and should not be allowed to grow to a much greater height. Great care must be exercised to prevent fires from burning them, as they are likely to destroy the roots and thus create a condition favorable for washing of the slopes.

Where the erosion results from the cutting action of stream flow along the base of an embankment, the best solution is to divert the ditch or stream to a new channel built far enough away to leave a wide berm between the toe of the embankment slope and the edge of the channel. But in the many locations where this cannot be done, the only solution is to protect the slope with rip rap.

Drainage

Although the various corrective measures described above are important, they are not nearly so vital as drainage, as few defects in embankments produce serious results unless water is present. Conversely, the removal of water from the material of which a fill is composed will eliminate most of the troubles.

As has been noted previously, water entering the fill from waterbearing strata near its ends, or which enters the ground under the fill and lubricates slippery supporting strata, is sometimes the cause of serious troubles, but by far the most frequent source of trouble is the water that falls on the roadbed as rain or snow and spreads through the fill material through the agency of the water pockets. The cure of water pockets is, therefore, one of the most vital problems connected with the proper maintenance of embankments.

Accurate Survey Necessary

The removal of water from water pockets calls for artificial drainage, although the first requisite in dealing with the problem of draining water pockets is an accurate survey of the physical conditions presented. This consists in the main, of a series of soundings to deter-

mine the depth of the water pockets, for more failures in drainage jobs have resulted from failure to reach the bottoms of the pockets than from any other cause. It is necessary to determine the lateral variations in the depth of the pockets as well as the variation in the longitudinal direction, since the depth will almost invariably be greater directly under the rails than along the center line of the track, and in many cases the depth will be greater under one rail than under the other.

A careful plan should be developed for the placing of lateral drains, choosing the locations and providing a sufficient number of laterals to insure that all the water

An Outfall Drain Carried Down the Embankment Slope

will be drained off. In former years French drains, or trenches filled with loose rock, were used almost exclusively for this purpose, but during the last 6 or 8 years, perforated corrugated pipe from 6 to 8 in. in diameter have almost entirely replaced French drains for this purpose.

On single track lines, it will suffice in most cases, to allow these drains to project out of the side slope of the embankment, care being taken to protect the slope from erosion. On double-track lines it is preferable to run the laterals into a longitudinal pipe line along the center line between tracks and dispose of the water from this longitudinal line by means of an outfall pipe line carried down the embankment slope with a suitably protected outlet at its lower end. The trench in which the longitudinal line between the tracks is placed should preferably be backfilled with loose rock.

Treatment of Extreme Conditions

In those cases in which a serious water-pocket condition of the embankment has been allowed to go so far that a considerable portion of the entire mass of the embankment is saturated with water, much more comprehensive corrective measures must be taken. In such cases, the survey must extend over the entire embankment, even far down the slopes, and the results of all borings must be carefully tabulated and platted for the purpose of accurately locating the water-charged portions of the fill. With this information available, a plan must be developed for a complete system of drainage which may involve the driving of tunnels under the embankment, from which as many lateral and riser pipes as are necessary must be jacked into the surrounding material for the purpose of drawing off the water. Such measures are expensive, but they comprise the only effective cure of an exceptionally costly and often hazardous condition short of the complete removal and replacement of the embankment.

Committee: J. P. Corcoran (Chairman), supervisor, Alton, Bloomington, Ill.; W. M. Anderson, roadmaster, S.A.L., Birmingham, Ala.; W. E. Carter, supervisor of track, B.& L.E., Greenville, Pa.; P. Chicoine, roadmaster, C.P.R., Smith's Falls, Ont.; Adrian del Paso, chief engineer maintenance of way, National of Mexico; C. M. Hayes, assistant general roadmaster, Soo Line, Minneapolis, Minn.; A. L. Kleine, roadmaster, A.T.& S.Fe., Marcelline, Mo.; W. C. Pruett, assistant general foreman maintenance of way, M-K-T., Muskogee, Okla.; W. L. Spyres, roadmaster, K.C.S., De Quincy, La.; H. L. Stein, roadmaster, C.B. & Q., Edgar, Neb.

Discussion

W. S. Lacher *(Railway Engineering and Maintenance)* questioned the committee's recommendation that material for widening embankments be placed preferably by train haul and spreading, because he saw no reason why the placing of the material in layers would not produce an equally or more stable embankment. Chairman Corcoran replied that in most cases train-haul material can be placed more cheaply. J. A. Spurlock (M-K-T) favored the placing of materials in layers if the conditions favored teamwork or the use of tractors, but that in some cases he had placed train-haul material in layers.

J. Morgan (C. of Ga.) emphasized the importance of avoiding the use of coarse ballast on a new fill as this tends to produce water pockets. E. B. Fithian (M.P.) recommended stone screenings or stone dust as temporary ballast to avoid the formation of water pockets.

In answer to a question concerning the distances over which it would be economical to haul material for the purpose of avoiding difficulties with soft material available closer at hand, J. B. Kelly (Soo Line) replied that it was a matter of dollars and cents and that in some cases it would be more economical to use less satisfactory material and go to the expense of drainage than it would be to haul better material greater distances.

In discussing the curing of water pockets, F. B. Lafleur (S.P.) reviewed several methods that he had found effective. In especially severe cases, green cypress piles were driven in the shoulders of the embankment 30 in. center to center and the bank was widened out on a slope of 4 to 1. In cases where the difficulty extended over a distance of not more than 100 ft., the embankment was dug out to the bottom of the pockets and replaced with impervious material or with gravel or other pervious material where it was available. In some cases where this trouble was encountered second-hand ties were driven in the shoulders of the embankment.

W. H. Sparks (C. & O.) contended that much of the trouble with water pockets has been brought about as a result of the enormous increase in weight of rolling stock, which had the effect of pressing the ballast down between impervious material on each side. He also reported that severe troubles were encountered in a new embankment subjected to heavy traffic immediately after its completion.

In reference to the selection of material for the widening of embankments, M. Donahoe (Alton) called attention to the fact that such work is often of an emergency nature and it is necessary to use whatever material is available in the shortest time. William Shea (C.M. St.P. & P.) contended that a large part of the water pockets are produced by the depression of the roadbed between shoulders of impervious material, thus forming a trench into which water flows from the downhill ends of cuts, and that in his opinion the first corrective measure

in many cases is to dig a transverse trench in the roadbed at the end of the cut and fill it in with stone to produce a French drain that will keep the water in the cut from flowing out on to the embankment. C. L. Isard (M.P.) reported the use of corrugated perforated pipe as laterals for the draining of the water pockets; he also stated that he had made use recently of four-inch super-heater tubes —which had been perforated with ¾-in. holes and projected into the water pockets through holes provided by means of augurs.

Permanent Track Construction—To What Extent Is the Expenditure Justified?

By ROBERT FARIES

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Robert Faries

A DEFINITION of permanent track construction might well be given as follows: "A structure which, notwithstanding the loads, stresses and abuse to which it is subjected, retains its original exact position as to location and elevation and which is composed of materials not affected by wear or the action of the elements." Of course, there is no such known construction. When consideration was first given to track construction, it was proposed to give permanence to the structure by the use of stone blocks as foundations upon which the rails were to rest. This idea was soon abandoned as it was found unsatisfactory even with the extremely light loads of those days. The wood tie and T-rail construction which replaced it has been in general use ever since.

At various times attempts have been made to provide construction of a more permanent type, usually without success, except for some special locations limited in extent. Briefly, these substitutions have consisted of one of the following: Ties of concrete or metal; a concrete slab in place of ties and ballast; concrete slabs as a base upon which to construct the present track consisting of ballast, ties, tie plates and rail; and a few types in which longitudinal members were placed under the rails.

Substitute Ties

The substitute ties are reported upon regularly by the Committee on Ties of the American Railway Engineering Association. My knowledge of the subject is confined to an extensive experiment with concrete ties on the Pennsylvania. The type of ties employed has proved unsatisfactory, some of them crushing under the rail, others breaking off at the ends and many of them rotating in the ballast. These defects can be corrected by design and the better concrete it is possible to make today; but our studies of costs, advantages, disadvantages and savings, based upon our present knowledge, indicate a required life that we doubt would be secured. Definite information on this point can be obtained only by extensive tests of an improved design.

Of the forms of concrete slab replacing ties and ballast, the few that have been put in use have been in tunnels and terminal station areas, with the notable exception of the experimental track on the Pere Marquette. There have been several installations in tunnels that have not proved satisfactory. In one case failure was attributed to the fact that the slab was situated directly between the rail and a solid rock foundation, and was shattered by the blows on the rail. In another case the foundation material was of such a soft and yielding nature that the slab settled, resulting in cracks and deterioration. Some of the installations in terminal station areas have proved satisfactory, and the improved type of construction used by the Pere Marquette has proved entirely satisfactory.

The concrete slabs replacing sub-ballast have been confined to a few installations of restricted length in a few locations where roadbed conditions are extremely poor and where it was felt that no cheaper cure could be effected. In most of these locations they have been satisfactory and have resulted in reductions in maintenance costs commensurate with the capital expenditures required to construct them.

Cost of Concrete Slabs

I have examined forms of concrete slab construction of the type which replaces ballast and ties; and considering that type which seems to be the most favorable, and dimensioning it for use on a railroad of heavy traffic with present-day axle loads, I find that it would cost $72,400 per mile. The annual cost of the component parts of this construction, assuming unlimited life for reinforced concrete (interest at six per cent) plus a figure of $170 per mile for minor adjustments about the rail seats or correction of minor settlements and heaving, shows a total annual carrying cost of $4,733. In this calculation, I have assumed 100-lb. rail as sufficient because of the continuous support afforded the rail, although this assumption is subject to very grave doubt. I have estimated the cost of the present form of construction for one mile of track for heavy-traffic territory, with 131-lb. rail, at $32,000 per mile. The annual cost (interest at six per cent) plus a figure of $630 for ballast cleaning and for restoring line and surface, amounts to $3,013, giving a difference of $1,720 annually in favor of the present construction.

I have estimated the saving which may result from decreased train resistance, the data used being taken from actual tests of train resistance in several different locations. This saving will not exceed $225 per mile of track per year on heavy-traffic lines. It is apparent, therefore, that even though such construction would prove permanent for the reinforced concrete component, it is only at such locations where the cost of preserving suitable line and surface is approximately 3½ or 4 times the normal

cost that it could be justified, and then only in case other and cheaper means of relieving the expense could not be found. Such locations as tunnels through wet and unstable soil, track troughs, or similar situations where unusual conditions exist are the only places which indicate a necessity for study in this connection. Such a study should also include for consideration a concrete slab in place of the sub-ballast which confined track ballast and ordinary track construction.

Studies Should Be Continued

I do not want to give the impression that I do not favor continued efforts to develop a better form of track construction than we have today. I want to make it clear that my present knowledge of those special forms of construction so far developed indicates that there is a very limited field in which they could be justified under present conditions. However, it would be unfortunate if the present studies were not continued with vigor, and experimental work broadened, so that with changing times and requirements we would not have available for consideration better types and, it is to be hoped, types not requiring such large immediate expenditures.

The outstanding characteristic of all these special types of construction is an exceedingly high first cost which, even if the installation is made where the costs of maintaining the ordinary form of track are so high as to justify the special construction, would require a long period of service to realize fully upon the investment.

The necessity for an immediate improvement in the financial condition of the railroads generally is such that I believe a study of what can be done with moderate expenditures to secure large and immediate savings, by making the present form of track structure and roadbed as permanent as possible, will be easier to justify. The extent to which the present track construction can be advanced toward permanence is probably not fully appreciated. This fact should also be recognized when comparing costs and returns as against such costs and returns for special types of construction that are called "permanent" for want of a better name.

First Step the Stabilized Roadbed

The first step in an advance towards permanence is to secure a stabilized roadbed. No matter how permanent the track structure itself, the advantages are completely nullified by a settling embankment. Fortunately, it is in this field that the largest returns can be secured at moderate cost. Roadbed troubles are usually due to the presence of water. The prevention of the flow of surface and ground water to the roadbed, the drainage of water pockets in the roadbed and provision for quickly draining from the track the water that falls upon it will have a far-reaching effect in saving labor, ballast and ballast cleaning, and in eliminating damage to ties caused by frequent tamping.

There are other savings. As an example, a recent rainstorm of unusual severity affecting a 20-mile width swept across a portion of our eastern territory. The path of this storm crossed two of our important lines. One of these lines had been provided with ditches 6 to 7 ft. deep and of ample width, the primary object being to lower the water level in the roadbed. The other line had not been so treated. The ditches were what might be called "Mid-Victorian." The latter line was washed out and damaged in a dozen locations, ballast was fouled and traffic badly delayed. The former line suffered no damage whatever, nor any train delay, notwithstanding that it was subjected to the same storm conditions.

For one or two years immediately preceding the depression, the Pennsylvania spent substantial sums in a system-wide program of roadbed stabilization. The returns, which have been carefully checked for nearly every one of the individual projects, have already been sufficient to return the investment.

The stabilization of the roadbed itself is the way to commence to make permanent track, no matter what form the ultimate construction may take. Further steps towards securing permanence must, of course, be directed toward some definite form of track structure. Owing to the fact that there has not yet been developed a more permanent form of track that can be financially justified in territory where ordinary maintenance costs prevail, we should examine the present type of track structure to determine what advances towards permanence can be made at moderate cost, the returns from which will be immediate and attractive.

To give the greatest possible permanence to the ballast, there is required, first, ample depth of ballast and proper sub-ballast to distribute the pressure so as to avoid displacement of the subballast or roadbed material; and, second, ample embankment shoulder and ample ballast shoulder. It is my opinion that many loose ties could be avoided if the proper amount of ballast is provided to bed the ties firmly and to prevent them from being worked loose by tamping. It seems to me there may be a field for some simple device or form of construction which can be used as an aid in confining the ballast around and under the tie without interfering with drainage.

The great step to give permanence to ties was taken when the railroads of this country commenced the general use of treated ties. The value of this step can hardly be over-estimated. It is enlightening to consider the effect of this one move towards permanence, which affected but one part of the track structure. However, a great deal remains to be done. The prevention of the splitting of ties can be accomplished by several devices now in use or recently developed. The elimination of abrasion under the plate and around the spikes can be accomplished by a better plate and more adequate rail holding construction. These should add very materially to the already extended life of the ties.

The greatest approach to permanence that can be secured in rail will come about through a general improvement in rail steel, which will be accomplished, if the transverse fissure problem can be solved, through the heat-treating of rail ends and through precision surface grinding of the joints. Work of this character strikes at the cause of track disturbance and, therefore, is more desirable than work which simply restores.

The increase in the weight and stiffness of rail, with mounting axle loads, is an engineering accomplishment amply justified by experience. The permanence of a track structure is increased by the stiffness of the rail, and where rail is inadequate in stiffness the best step towards improvement is the correction of this deficiency.

Estimating Savings

In applications for authority for capital expenses to cover all the projects and methods which I have mentioned, the presentation of the facts fixing definitely the costs and the resulting savings to be secured requires a great deal of care. The task of estimating the cost of doing the work should not present great difficulty, since units of cost of various operations are pretty well fixed. Estimates of savings are more difficult; it is hard to secure facts, so some persons assume their facts and try to make up the deficiency by logic and reasoning. But this difficulty disappears if the practice is followed

of requiring a check of the savings concerning typical projects after they have been completed for a sufficient length of time, and the information thus obtained is used to adjust estimates of savings currently. In some of these cases it is necessary to follow through the service life of materials in test locations in order to arrive at a true figure for savings. A blanket program promotes neglect of investigation of individual projects and the insertion of projects in the program without full study, thus presenting an opportunity for waste to creep in with an entry on the wrong side of the ledger.

From the purely financial standpoint, the percentage of savings estimated by exact methods by practical men and applying to individual projects, not blanket authorities, should give the answer to the question: "To what extent should railroads make capital expenditures for permanent track construction?" or, as I have preferred to view it, "For an approach to permanent track construction."

Also related to this question are such subjects as the possible consolidation of railroad lines with attending abandonments; the possible use of lighter equipment; the social question of unemployment; and, finally, the actual inability to make capital expenditures due to the many burdens imposed on railroads generally.

The consolidation problem has been or is being studied fully and those lines affected are generally known. The main arteries of transportation will probably not be greatly affected. The problem presented by a proposed capital expenditure on a line of questionable life should be solved by a consideration of the amount of saving to be secured. It may be possible that even on a line of such character the project may carry such a high percentage of saving as to make it attractive. While there may be profound changes in methods of carrying out the business of the railroads, it seems inevitable that the traffic of this country in coming years will not only require but will tax the capacity of the great railroad arteries of transportation.

The use of lighter equipment, when it may be established, will to some extent be balanced by an increase in speed. I do not believe that the gross weight (car and lading) of freight cars will be decreased to an appreciable extent as the result of future developments.

Economies of Sound Projects

I wish to call attention particularly to this fact. Projects such as I have described, by immediate and local saving, go at once to the credit side of the ledger and work day and night, and year after year, as long as the facility remains in service. Unsound projects conceived without consideration of all the facts go on the debit side, reducing the wealth available for wealth-creating enterprises, eventually increasing taxation, lowering the standard of living, and adding to unemployment. It is a narrow view that concludes that the immediate and local saving in labor, resulting from a sound project, increases or contributes to unemployment. If a project is sound, just the reverse is true. Millions of men are gainfully employed today, notwithstanding the ravages of the depression, because of a security won by good management, sound policy and the discipline of thrift in past years.

The improvements in question are not of the character of those which expand a plant beyond the possible business to be done by that plant, which is definitely waste. On the contrary, they are of a character which handles in a better way the business available, definitely increasing gross wealth and resulting in a sound financial condition.

Is there anything more necessary in this country today than the restoration of the tremendous purchasing power of the great railroad systems, and a release of the potential employing power of these systems? I think not. Anything that will help towards obtaining this condition is not only desirable but of extreme urgency. Therefore, I would answer the question "To what extent can the railroads make capital expenditures for the most practical approach to permanent track construction?" this way: Because of the profound effect upon the country as a whole, there is no better way to spend money in the country today than to spend it in improving the financial condition of the railroads. Therefore, every effort should be made to place the managements of these railroads in a position to take advantage of projects which stand the test and examination of practical engineers so that wealth and employment can be increased. This result can be accomplished effectively by lifting the many burdens now imposed upon the railroads, burdens which clearly go on the debit side of the ledger by working to decrease wealth and employment. Let me list some of these burdens:

Subsidized competition—highway and waterway.

Regulation of carriers and non-regulation of competitors.

Wasteful regulations governing hours of labor.

Requirements for large expenditures in connection with rebuilding and enlarging overhead and undergrade highway bridges, the benefits of which accrue entirely to competitors of railroads.

Inability to abandon lines which fall far short of paying their way.

Excess-crew bills.

Bills limiting the length of trains.

Added expense, in these difficult times, in connection with the government pension bill.

Reduced rates regardless of railroad needs.

Restrictions in legislation preventing arrangements tending toward economical operation.

Increased taxes taking a greater proportion of the income dollar.

These burdens are far beyond the ability of the industry to support and as stated by B. C. Forbes in a recent article, "A prosperous America is impossible under a bankrupt railway transportation system". Therefore, it is the responsibility of every railroad employee to give consideration to the ultimate well-being of the industry and to do everything in his power, using all legitimate means and contacts available, to aid in bringing relief along these lines. If these burdens can be lightened, the railroads may once more enjoy that financial security now so much to be desired.

Discussion

J. B. Kelly (M.St.P. & S.S.M.) inquired whether, with the heavier rail sections, it would be possible to go to a wider tie spacing. Mr. Faries replied that the support of the track depends largely on the stability of the ballast and that, therefore, as close spacing of the ties as is practicable is desirable. Paul Chipman (P.M.) stated that the cost of the concrete slab installed on the Pere Marquette is estimated to be $50,000 per mile per track, in contrast with Mr. Faries' estimate of $70,000. In reply, Mr. Faries said that he had based his estimate on an axle load of 85,000 lb. calling for a heavier type of construction than that installed in the Pere Marquette tracks. J. V. Neubert (N.Y.C.) said that caution should be used with making capital expenditures to secure permanent construction, calling attention to the fact that the roads have already done a large amount of work leading to stabilization of the roadbed and track, particularly in drainage and heavier track construction. He did not favor a reduction in the number of ties to the rail as the ties and ballast in combination must support the traffic loads and distribute them to the roadbed.

Spot Versus Group Renewal of Cross Ties

Report of Committee

E. H. Piper
(Chairman)

ONE of the largest single items of material expense with which railroads are confronted is that of crosstie renewals. Not only the cost of the materials, but also the labor incidental thereto, constitute an item that should receive the closest attention of the management, and particularly of maintenance officers.

The crosstie, it may be said, is the foundation of the track structure, although the ballast and subgrade are vital factors in this foundation. Table 1, taken from the annual reports of the Class I steam railways to the Interstate Commerce Commission, covering the Analysis of Operating Expense Accounts, clearly sets forth the heavy expenditure necessary to provide for this one item of maintenance of way material. The table is presented to illustrate the amount of money expended for the various activities incident to railroad operation. Fuel constitutes the largest single item of material expense, followed by ties. The tie, therefore, comprises one item of expenditure in which maintenance officers are vitally interested today.

Table II, covering statistics on crosstie renewals per mile of maintained track for the years 1929 to 1933, inclusive, as compiled by the Bureau of Railway Economics, Washington, D. C., for the A.R.E.A. Committee on Ties clearly indicates how tie renewals on some of the leading railroads in the United States have dropped during the "depression years". While the tabulation discloses some marked variations in the records of different roads, caution should be exercised in making comparisons, because of many factors influencing renewals. The renewal of a small number of ties per mile on some roads, shown in the tabulation, may represent a better average tie condition than on another property where renewals were perhaps in excess of 200 per mile. In considering the average rate of renewals for any railway in 1933, it is necessary to take into account its record in previous years; for example, the renewal of only 75 ties in 1933 by a railway that inserted an average of 373 ties per mile in 1928 obviously implies a much larger decline in average tie condition than is the case on a railway that placed only 72 ties per mile in 1933 but had a renewal rate of only 85 ties in 1928, and 79 in 1929. Of course, comparison cannot be the criterion in all cases, because this implies that renewals were normal in 1928 and 1929, which was not necessarily true on all railroads.

Increase in Use of Treated Ties

Table III, showing the crossties inserted during the years 1920 to 1933, inclusive, by the Class I railroads of the United States, according to figures issued by the Bureau of Railway Economies, is also an interesting compilation, indicating the marked downward trend during the past four years. A very noteworthy feature is that indicating the increased use of treated ties, with a relative decrease in the use of untreated material. During the 10-year period, 1920 to 1929, inclusive, an average of 82,135,342 ties were used annually. During 1923 the number of treated and untreated ties were about equal, but the use of treated ties increased thereafter until 1928, when 76 per cent of the total ties were treated. With declining business, tie renewals were materially reduced, dropping to a low of 37,294,836 during 1933.

Treated ties are now almost universally recognized as a necessity. Good treatment, however, is only the beginning, as ties must be sound, well made, and of adequate size to take the larger tie plates now in vogue.

Table I—Analysis of Operating Accounts for Period 1920-1932 Class I Steam Railways as Prepared by Bureau

	1932	1931	1930	1929	1928	1927	1926	1925
1) Maintenance of Way and Structures								
Rail	$ ·13,761,984	$ 25,960,410	$ 34,638,993	$ 44,191,266	$ 50,045,082	$ 49,764,212	$ 48,834,988	$ 44,163,461
Ties	50,293,563	72 ,651,560	91,223,815	109,195,098	114,087,404	116,917,139	115,646,161	118,499,004
Ballast	4,959,000	8,601,217	13,261,752	20,979,553	19,391,647	20,042,821	20,145,690	16,335,774
Other Track Material	15,726,144	26,505,617	36,293,586	43,355,909	48,286,819	50,553,544	51,341,685	47,632,597
Track Laying and Surfacing	83,407,174	131,274,092	172,436,675	210,496,389	207,433,261	218,108,279	218,460,417	200,836,501
Roadway Maintenance	32,042,284	48,338,496	64,794,990	86,335,749	83,385,371	89,597,089	82,918,121	77,254,002
Bridges, Trestles, and Culverts	19,150,021	27,974,894	37,339,133	44,390,306	42,206,698	41,596,443	44,185,691	43,781,667
Buildings, Wharves, Docks, Etc.	28,876,120	48,838,868	72,777,687	92,354,025	86,489,377	89,301,659	92,752,479	86,602,707
Telephone and Telegraph Lines	6,136,362	7,987,888	10,910,987	12,361,669	11,524,631	11,983,754	12,152,821	11,456,577
Signals and Interlocking	16,771,739	25,277,833	32,286,720	35,140,858	32,156,729	32,847,323	31,208,948	30,047,620
Roadway Machines, Small Tools—Supplies	7,917,654	11,834,409	16,534,445	19,859,412	17,812,769	18,668,759	18,823,625	16,984,942
Depreciation	4,588,353	5,324,214	6,761,849	6,679,858	6,597,127	8,552,946	10,246,005	9,408,452
All Others	67,548,643	90,043,392	116,210,308	130,014,775	118,488,832	120,647,464	120,102,734	113,439,811
Total	$ 351,179,041	$ 530,612,890	$ 705,470,940	$ 855,354,867	$ 837,905,747	$ 868,581,432	$ 866,819,365	$ 816,443,205
(2) Maintenance of Equipment								
Steam Locomotives	$ 192,225,076	$ 271,207,221	$ 345,389,094	$ 409,555,027	$ 404,670,724	$ 435,564,729	$ 460,544,091	$ 456,532,571
Freight Train Cars	104,890,365	187,609,247	262,884,111	338,079,151	325,278,852	340,695,795	377,702,544	373,314,353
All Others	321,825,332	358,137,023	410,992,073	455,278,068	436,992,344	442,791,004	444,844,664	429,988,342
Total	$ 618,940,773	$ 816,953,491	$1,019,265,278	$1,202,912,246	$1,166,941,920	$1,219,051,528	$1,283,091,299	$1,259,835,276
(3) Traffic	$ 96,222,857	$ 117,217,756	$ 127,833,478	$ 130,157,630	$ 125,007,867	$ 120,349,440	$ 114,690,513	$ 106,052,896
(4) Transportation (Rail Lines)								
Station Employees	173,154,862	230,456,917	268,654,479	296,567,553	297,607,740	304,859,956	309,087,818	306,474,898
Fuel	168,601,492	222,094,409	282,886,293	336,654,815	354,185,590	385,656,914	407,431,929	407,263,044
Train, Engine, Yard, Motor Men	399,994,612	544,383,573	654,225,642	749,347,163	732,868,840	740,042,494	748,943,741	724,859,943
All Others	412,566,849	541,534,434	635,961,751	689,473,378	676,478,793	696,946,604	706,441,366	689,873,333
Total	$1,154,317,815	$1,538,469,333	$1,841,728,165	$2,072,042,909	$2,061,140,963	$2,127,505,968	$2,171,904,354	$2,128,471,218
(5) Transportation (Water Lines)	$ 3,456,599	$ 5,274,687	$ 6,455,275	$ 7,911,117	$ 8,786,205	$ 9,481,244	$ 9,612,724	$ 9,838,823
(6) Miscellaneous Operations	27,684,028	41,051,764	52,140,923	58,447,412	55,705,391	55,766,966	56,063,868	53,944,820
(7) General	155,568,422	181,523,611	191,237,312	193,887,116	188,190,714	191,081,367	184,389,906	175,528,516
(8) Transportation For Investment Credit	3,924,640	7,528,916	13,202,684	14,657,035	15,683,771	17,640,124	17,235,293	13,234,463
Total Railway Operating Expense	$2,403,444,895	$3,223,574,616	$3,930,928,687	$4,506,056,262	$4,427,995,036	$4,574,177,821	$4,669,336,736	$4,536,880,291

Ties must be further protected against service abuse by adzing and boring before treatment. A reduction in spiking by fastening the tie plate to the tie independent of the rail spike further reduces mechanical wear.

Other factors tending to reduce tie renewals are proper and sufficient rail anchorage, heavier and improved angle bar design, and rail end welding, all of which have greatly reduced the mechanical wear of ties. A very important factor contributing to reduced tie usage during the last four years is the heavy decline in freight traffic and the consequent reduction in mechanical wear. The abandonment of branch lines will also further reduce tie renewals, and it is reasonable to anticipate further abandonment of branch lines, particularly with continued appropriations by the government for highway improvement.

Considering the wide spread in tie renewals from the 10-year average of 82,153,342 from 1920 to 1929 to a low of 37,294,836 during 1933, it is quite obvious that some deficiency exists. It is also quite obvious, considering the rapidly increasing installation of treated ties, that the average figures of the years 1920 to 1929 do not represent today's normal requirements. It is believed, likewise, that the average renewal of 42,662,323 ties in the three-year period from 1931 to 1933, during which forced reductions were made, represents subnormal installations. An average figure representative of normal requirements may be deduced from the high average of the period from 1920 to 1929, and the low average of the 1931 to 1933 period, or approximately 62,000,000 ties annually. This compares quite favorably with the renewals of 1930, when 63,353,828 ties were used and can be assumed as representing a more normal year. It is quite obvious, considering improved and heavier rail sections, angle bars, joint rail and welding, anchorage, larger and heavier tie plates, the extended use of treated ties, the decreased volume of freight traffic, abandonment of branch lines, etc., that tie renewals will never again attain the proportions of former years.

Table III—Ties Laid in Previously Constructed Tracks

Year	Untreated Ties	Treated Ties	Other than wood and S. H. Ties	Total all Cross Ties
1920	48,631,543	37,792,431	154,378	86,829,307
1921	49,238,665	36,071,989	536,188	86,521,556
1922	45,212,085	40,629,943	554,250	86,641,834
1923	42,072,140	41,655,616	447,002	84,434,985
1924	38,317,244	44,489,687	3,360	83,073,059
1925	32,623,486	50,089,966	3,222	82,716,674
1926	25,184,662	55,557,706	3,141	80,745,509
1927	21,240,053	57,082,993	17,136	78,340,182
1928	18,191,677	59,157,540	21,724	77,370,941
1929	15,614,898	59,047,380	17,097	74,679,375
1930	13,618,718	49,720,080	15,030	63,353,828
1931	11,658,836	39,827,791	15,032	51,501,659
1932	9,740,686	29,435,055	14,732	39,190,473
1933	10,844,161	26,001,769	448,906	37,294,836

of Statistics Interstate Commerce Commission

1924	1923	1922	1921	1920
$ 39,921,313	$ 34,515,256	$ 33,416,025	$ 37,798,508	$ 28,843,581
121,013,063	116,240,452	120,841,322	136,174,593	124,536,112
15,527,528	18,250,466	13,165,536	13,206,580	20,974,729
46,683,299	40,649,240	36,927,643	43,692,464	42,088,249
196,053,696	209,605,688	179,128,590	201,334,558	307,315,549
76,305,345	85,124,116	75,411,405	86,331,390	129,573,191
42,977,611	43,557,108	39,815,229	40,122,082	53,412,069
84,133,285	91,691,648	73,203,583	70,848,018	109,225,806
11,167,895	10,832,222	9,209,565	9,445,094	11,816,057
26,944,836	26,037,386	23,948,595	23,570,382	28,580,710
15,990,821	17,301,759	14,801,408	14,197,624	19,251,648
8,568,321	8,364,790	6,965,630	6,795,558	5,839,904
107,391,010	111,517,815	101,829,003	122,896,839	151,082,776
$ 792,678,023	$ 813,688,760	$ 728,663,534	$ 756,413,690	$1,032,540,381
$ 465,131,860	$ 559,280,737	$ 439,636,745	$ 448,491,257	$ 601,066,932
380,925,733	475,433,689	407,565,747	466,568,343	591,545,156
413,962,323	430,442,169	405,314,758	336,419,843	397,752,552
$1,260,019,916	$1,465,156,595	$1,252,517,250	$1,251,479,443	$1,590,364,640
$ 98,873,241	$ 93,976,686	$ 86,506,907	$ 84,183,424	$ 74,530,997
307,517,043	314,440,211	295,771,405	320,383,517	399,059,915
437,141,694	529,219,236	518,283,929	523,724,145	674,836,361
704,272,913	744,596,474	644,467,094	633,438,698	839,566,133
692,537,605	721,352,845	681,627,168	774,544,543	978,200,077
$2,141,469,255	$2,309,608,766	$2,140,149,596	$2,252,090,903	$2,891,662,486
$ 10,509,914	$ 11,674,372	$ 9,614,227	$ 10,380,945	$ 12,423,949
50,212,743	50,647,090	47,653,795	48,499,572	61,593,013
167,819,209	162,057,024	156,705,481	166,515,125	173,088,251
13,697,264	11,642,474	7,288,456	6,894,800	5,583,225
$4,507,885,037	$4,895,166,819	$4,414,522,334	$4,562,668,302	$5,830,620,492

Spot renewal implies tie renewals made generally with section forces, and dug in as they are necessary.

Group renewal implies tie renewals made in larger numbers, generally in connection with surfacing work, where the digging in of ties is deferred to some extent until a general surfacing of track is necessary.

Out-of-face renewals necessarily imply entire out-of-face replacement, which is not as yet in vogue in the United States, but is the practice of some European roads.

In a canvass of the practices followed on various railroads, replies from maintenance officers of 33 leading railways, representing every region in the United States, and comprising a total of 175,020 road miles, indicate that three methods generally prevail.

Class I—Spot Renewals

A review of the replies indicates that the majority of the railroads follow the practice of making spot renewals. Comments of officers of roads conforming to this policy are given below:

E. E. Oviatt, chief engineer of the New York, New Haven and Hartford, states it is the practice to spot ties rather than make group renewals.

George H. Harris, chief engineer of the Michigan Central: "Ties for renewal each year are spotted by the section gangs and checked by the roadmasters and division engineers; that is to say, ties are renewed only where actually required, no renewals being postponed beyond the normal life of the tie in order that larger numbers would be removed at one time with extra forces."

J. V. Neubert, chief engineer maintenance of way of the New York Central: "We renew crossties and switch timber, as a general proposition, by spot renewals outside of some special cases in terminals. This is generally carried on by regular maintenance force as well as extra gangs."

E. L. Crugar, chief engineer of the Wabash: "The Wabash follows the spot method of renewals. By this method we are reasonably sure that we get the maximum life out of the ties. Even when surfacing track out-of-face with small floating or extra gangs, we follow the same procedure."

W. P. Wiltsee, chief engineer of the Norfolk & Western: "Our crossties are placed by section gangs. We use the spot method of renewing crossties, and up to the present time, we have used the group method of replacing switch timber. Bridge ties are placed by the spot method if the renewals comprise less than 25 per cent of the ties in the structure. Frequently the bridge ties are renewed over a part of the structure out-of-face, and ties that may have several years additional life and are in that part of the structure over which the ties are renewed out-of-face, are transferred to the other part of the structure. Our method of renewing bridge ties thus depends a great deal upon the judgment of the carpenter foreman and the supervisor of bridges and buildings when making the renewals. We have always felt that the spotting-in method for renewing ties is the most economical. I cannot see any very good argument for renewing crossties out-of-face. Our section foremen place these ties during about nine months of the year, beginning on the eastern end of our railroad early in March, and finish about the latter part of November. They first place crossties in the main tracks of our most important lines, such as our main line from Norfolk to Columbus, and our important side lines and important heavy-traffic branches. The ties are generally all placed in those lines before the first of August. The section forces then place crossties in side tracks and unimportant branches during the fall. On several occasions we have considered very carefully the question of renewing our ties by extra forces rather than have our section forces do this work, but could figure no economy in doing so;

in fact everything points to the maintenance of good track by renewing these ties by the spot method as it becomes necessary. It is much better to distribute the crossties evenly throughout the years, for the fewer ties it is necessary to renew each year the better track we will have."

R. R. Nace, engineer maintenance of way of the New York region of the Pennsylvania: "It is our practice to make crosstie renewals by what is termed the 'spot' system, that is, only such crossties are removed from track as are either decayed, worn out, or otherwise unfit to bear the burden of traffic and maintain the gage, surface and line of the track in a satisfactory manner. The practice of making renewals 'in face', or renewing all crossties at or about the end of the normal life of most of them in a long stretch of track, does not obtain on the Pennsylvania."

J. B. Trenholm, engineer maintenance of way of the Atlantic Coast Line: "Our company has always spotted crossties as the most efficient and economical method of maintenance. We get the full life out of each crosstie before its removal, except that

Table II—Number and Aggregate Cost of Wooden Cross Tie Renewals Per Mile of Maintained Track and Ratio of Wooden Cross Tie Renewals to Total Wooden Cross Ties in Maintained Track

Class I roads in the United States, by years, and for the average of the five years 1929 to 1933 inclusive
Note: All figures are exclusive of bridge and switch ties

	Number of wooden cross tie renewals per mile of maintained track						Aggregate cost of wooden cross tie renewals per mile of maintained track						Per cent wooden cross tie renewal to all ties in tracks					
Road	1929	1930	1931	1932	1933	5 year average	1929	1930	1931	1932	1933	5 year average	1929	1930	1931	1932	1933	5 year average
New England Region:																		
Bangor & Aroostook	255	253	236	203	189	227	$212	$207	$183	$160	$126	$178	8.8	8.8	8.2	7.1	6.6	7.9
Boston & Maine	260	236	164	64	75	160	426	385	271	99	118	260	9.1	8.7	5.4	2.2	2.6	5.6
Canadian National Lines in N. E.	235	160	87	57	87	125	383	251	129	72	122	191	7.4	5.0	2.8	1.9	2.8	4.0
Canadian Pacific (lines in Me.)	311	320	262	181	170	249	395	397	362	270	242	333	10.8	11.1	9.1	6.3	5.9	8.6
Canadian Pacific (lines in Vt.)	326	313	254	200	134	245	385	413	362	297	192	330	10.6	10.0	7.5	5.8	3.9	7.6
Maine Central	204	244	222	184	167	204	224	273	257	212	162	226	6.7	8.0	7.3	6.1	5.5	6.7
New York, New Haven & Hartford	267	253	165	121	73	176	486	412	277	187	108	294	8.6	8.2	5.8	4.2	2.5	5.9
Rutland	270	224	210	189	147	208	459	365	337	270	174	321	9.3	7.5	7.0	6.3	4.9	7.0
Great Lakes Region:																		
Delaware & Hudson	201	172	111	125	139	150	519	432	266	289	297	361	6.7	5.7	3.6	4.1	4.6	4.9
Delaware, Lackawanna & Western	84	80	76	64	53	71	159	151	141	108	72	126	2.9	2.8	2.6	2.2	1.8	2.5
Erie (Inc. Chgo. & Erie)	221	199	173	135	106	167	480	422	341	248	154	329	8.2	7.0	6.1	4.7	3.7	5.9
Grand Trunk Western (see note)	303	191	156	115	141	181	400	252	210	155	179	239	9.4	5.9	4.8	3.6	4.5	5.6
Lehigh Valley	74	64	53	45	63	60	147	118	97	83	92	107	2.5	2.2	1.8	1.7	2.1	2.1
New York Central R. R. Co. (see note)	129	111	91	52	52	87	248	207	163	87	82	157	4.6	3.8	3.1	1.7	1.7	3.0
New York, Chicago & St. Louis	169	135	70	73	61	102	330	254	132	133	114	193	5.2	4.2	2.3	2.4	2.0	3.2
New York, Ontario & Western	134	119	116	105	90	113	244	206	196	163	107	183	4.7	4.2	4.1	3.7	3.2	4.0
Pere Marquette	213	168	191	140	118	166	302	294	319	213	149	255	7.1	6.4	6.3	4.7	3.9	5.7
Central Eastern Region:																		
Baltimore & Ohio (see note)	153	123	51	47	73	89	259	205	82	79	117	148	5.6	4.4	1.8	1.7	2.6	3.2
Central R. R. of New Jersey	79	83	82	72	45	72	164	156	151	131	77	136	2.8	2.9	2.9	2.6	1.6	2.6
Chicago & Eastern Illinois	119	101	98	100	92	102	181	152	145	144	96	144	4.0	3.2	3.2	3.2	3.0	3.3
Chicago, Indianapolis & Louisville	132	156	99	66	65	104	180	207	128	84	74	135	4.3	5.1	3.2	2.2	2.1	3.4
Illinois Terminal	77	94	84	83	90	86	115	130	105	103	87	108	2.9	3.5	3.1	3.1	3.2	3.2
Pennsylvania R. R. (see note)	159	124	75	48	58	93	312	227	138	81	97	171	5.8	4.4	2.7	1.7	2.1	3.3
Reading Company (see note)	148	137	105	28	29	89	289	247	188	47	48	164	5.2	4.8	3.8	1.0	1.1	3.2
Western Maryland	256	206	187	116	180	189	389	274	238	185	244	266	8.9	7.1	6.5	4.0	6.2	6.5
Wheeling & Lake Erie	267	171	133	46	78	139	446	258	203	67	113	217	8.9	5.7	4.4	1.5	2.6	4.6
Pocahontas Region:																		
Chesapeake & Ohio (see note)	211	173	127	84	92	137	283	239	157	102	105	177	7.1	5.6	4.1	2.7	3.0	4.5
Norfolk & Western	203	176	164	114	106	153	311	248	214	136	123	206	6.6	5.7	5.3	3.7	3.4	4.9
Virginian	355	342	234	169	205	261	387	373	249	193	225	285	11.3	10.9	7.4	5.4	6.6	8.3
Southern Region:																		
Atlanta, Birmingham & Coast	303	243	222	179	126	215	324	277	253	151	70	215	10.4	8.4	7.7	6.2	4.4	7.4
Atlantic Coast Line	234	218	210	186	152	200	262	238	214	157	91	192	8.1	7.5	7.2	6.4	5.2	6.9
Central of Georgia	204	144	143	109	116	143	190	131	120	84	79	121	7.3	5.2	5.1	3.9	4.2	5.1
Florida East Coast	62	36	34	93	172	79	106	40	32	51	87	63	2.2	1.2	1.2	3.2	6.0	2.8
Gulf, Mobile & Northern (see note)	235	220	142	136	119	170	250	223	148	109	81	162	7.5	6.9	4.4	4.4	4.0	5.4
Illinois Central	188	161	166	79	95	138	214	187	190	86	91	154	6.1	5.3	5.4	2.6	3.1	4.5
Louisville & Nashville (see note)	235	200	168	103	109	163	376	314	273	167	147	255	8.2	7.2	5.8	3.6	3.8	5.7
Mobile & Ohio	368	361	287	272	230	304	339	318	204	154	131	229	11.6	11.4	9.1	8.6	7.1	9.6
Nashville, Chattanooga & St. Louis	250	296	319	243	229	267	333	403	412	282	236	333	8.4	10.0	10.8	8.2	7.7	9.0
Norfolk Southern	283	306	228	163	284	253	241	269	169	99	150	186	10.1	10.8	8.0	5.7	10.0	8.9
Seaboard Air Line	251	227	258	215	204	231	254	227	238	161	135	203	8.1	7.3	8.3	6.9	6.6	7.4
Southern Ry	392	351	336	298	260	327	435	386	358	296	200	335	12.4	11.1	10.6	9.4	8.2	10.3
Northwestern Region:																		
Chicago & North Western	183	173	136	108	100	140	218	202	162	123	100	161	6.4	6.0	4.7	3.7	3.4	4.8
Chicago Great Western	205	220	243	247	179	219	219	255	281	264	179	240	7.1	7.5	8.3	8.5	6.1	7.5
Chicago, Milwaukee, St. Paul & Pacific	287	214	185	162	133	196	307	231	205	167	131	208	9.9	7.4	6.4	5.5	4.5	6.7
Chicago, St. Paul, Minneapolis & Omaha	282	223	255	201	152	223	341	263	287	229	111	246	9.5	7.5	8.6	6.8	5.1	7.5
Duluth, Missabe & Northern (see note)	225	174	160	11	38	122	389	289	257	14	53	200	7.3	5.8	5.4	0.4	1.3	4.0
Duluth, South Shore & Atlantic	272	235	214	157	155	207	207	179	148	84	70	138	9.1	7.9	7.2	5.4	5.3	7.0
Great Northern	205	190	168	140	49	149	254	224	190	138	37	169	6.4	6.0	5.3	4.4	1.2	4.7
Minneapolis & St. Louis	150	122	102	101	88	113	173	139	112	111	81	123	5.0	4.0	3.4	3.3	2.9	3.7
Minneapolis, St. Paul & S. S. Marie	238	222	173	164	169	193	259	271	193	173	143	208	8.1	7.5	5.9	6.0	5.8	6.7
Northern Pacific	169	124	103	101	97	119	208	156	127	122	105	144	5.8	4.3	3.6	3.5	3.3	4.1
Oregon-Washington R. R. & Nav. Co.	198	167	98	65	84	122	172	164	99	65	85	117	6.9	5.7	3.4	2.3	2.9	4.2
Spokane, Portland & Seattle	356	294	216	174	154	239	424	385	239	140	72	252	12.3	10.2	7.2	5.8	5.1	8.1
Central Western Region:																		
Alton R. R.	218	254	241	213	203	226	252	284	243	212	202	239	7.3	9.0	8.0	7.1	6.7	7.6
Atchison, Topeka & Santa Fe (see note)	176	160	117	82	83	124	253	221	155	104	102	167	5.8	5.3	3.8	2.7	2.7	4.1
Panhandle & Santa Fe (see note)	146	140	64	75	50	95	223	199	90	89	55	131	4.9	4.7	2.1	2.5	1.7	3.2
Chicago, Burlington & Quincy	168	151	134	106	64	125	218	195	170	133	78	159	5.4	4.9	4.3	3.4	2.1	4.0
Chicago, Rock Island & Pacific	156	128	106	38	46	95	173	141	116	42	51	105	5.2	4.3	3.5	1.3	1.5	3.2
Chicago, Rock Island & Gulf	184	185	98	44	55	113	254	296	161	74	96	176	6.6	6.1	3.3	1.5	1.7	3.8
Colorado & Southern	156	140	116	112	110	127	181	153	122	98	77	126	5.2	4.6	3.8	3.7	3.6	4.2
Denver & Rio Grande Western	198	175	162	130	129	159	234	210	190	141	126	180	6.4	5.6	5.2	4.2	4.1	5.1
Fort Worth & Denver City	212	178	90	68	31	116	284	240	118	88	37	153	7.0	5.9	3.0	2.2	1.0	3.8
Los Angeles & Salt Lake	167	132	124	112	137	134	252	215	202	182	233	217	6.0	4.7	4.5	4.0	4.9	4.8
Oregon Short Line	177	151	111	59	75	115	216	198	147	78	100	148	6.4	5.4	4.0	2.1	2.7	4.1
Southern Pacific Co.—Pacific Lines	202	164	137	97	57	131	261	198	164	105	56	157	6.9	5.6	4.7	3.3	1.9	4.5
Union Pacific	162	123	108	85	86	113	206	169	147	118	116	151	5.8	4.3	3.8	3.0	3.1	4.0
Western Pacific	426	338	261	199	277	300	337	281	211	127	163	224	14.9	11.6	8.9	6.8	9.5	10.3
Southwestern Region:																		
Gulf, Colorado & Santa Fe	205	191	125	59	64	129	260	227	142	72	66	153	6.3	5.9	3.9	1.8	2.0	4.0
International-Great Northern	214	204	167	93	123	160	268	235	190	91	112	179	7.1	6.8	5.6	3.1	4.1	5.3
Kansas City Southern	157	169	146	151	126	150	207	204	164	160	126	172	5.0	5.4	4.7	4.8	4.0	4.8
Louisiana & Arkansas (see note)	303	339	253	184	251	266	324	322	224	146	167	237	9.5	10.7	8.0	5.8	8.0	8.4
Missouri-Kansas-Texas Lines:																		
Missouri-Kansas-Texas	201	168	98	129	96	138	263	223	99	101	105	158	6.4	5.3	3.1	4.1	3.1	4.4
Missouri-Kansas-Texas of Texas	234	152	87	108	103	137	307	202	88	82	112	158	7.4	4.8	2.7	3.4	3.2	4.3
Missouri Pacific	294	217	164	96	164	187	303	232	186	99	142	192	9.5	7.0	5.3	3.1	5.3	6.0
St. Louis-San Francisco	204	168	124	167	204	173	228	190	137	166	188	182	6.6	5.4	4.0	5.4	6.5	5.6
St. Louis Southwestern Lines:																		
St. Louis Southwestern	332	260	90	75	52	162	455	312	111	91	61	206	10.5	8.2	2.8	2.4	1.6	5.1
St. Louis Southwestern of Texas	348	148	95	81	62	147	498	182	114	97	74	193	11.1	4.7	3.0	2.6	2.0	4.7

where stone ballast is being applied, the inspection is more liberal. Practically all of our crossties are placed in track by the section forces. The roadmaster watches closely the ties removed from track to insure full service."

J. R. Watt, engineer maintenance of way of the Louisville & Nashville: "Our renewals are made mainly by section gangs or small extra gangs, to which tie tampers have been assigned. The renewals very closely approximate the actual needs. The percentage of deferred renewals is very small. We operate a considerable portion of our line in a territory where curvature is sharp and where crosstie renewals cannot be postponed to any extent. We do not, therefore, have any very great variation in the condition of timber on the various parts of the line, but do make an effort to run the timber as long as it can be of service."

J. L. Kirby, chief engineer maintenance of way of the Seaboard Air Line: "We renew our ties by section forces."

Bernard Blum, chief engineer of the Northern Pacific advises that his road makes spot renewals.

J. A. Peabody, engineer of maintenance of the Chicago & North Western: "It is the general practice on the C. & N. W. to spot in ties. In a few instances we have put on gangs to make general renewals, but this has been rare."

J. G. Sheldrick, engineer maintenance of way of the Minneapolis, St. Paul & Sault Ste. Marie: "This company renews all ties with regular section gangs, and we allow each roadmaster sufficient man-hours to take care of tie renewals between April and July."

G. W. Harris, chief engineer of the Atchison, Topeka & Santa Fe System: "We have never followed the group renewal of crossties to any extent on the Santa Fe, but have used the so-called spot method. In the spot method or, individual renewal, the crossties are usually spotted by the section foreman, and checked by the roadmaster, or spotted by the roadmaster in company with the section foreman. The division engineer inspects enough of this spotting to satisfy himself that good judgment has been used in the selection of ties for renewal and the estimates which are made in the fall of the year are based on this spotting."

G. J. Adamson, chief engineer of the Union Pacific: "The practice on the Union Pacific is to have section foreman inspect all ties on their sections in the late fall, and mark with a paint spot each tie which in their opinion should be renewed during the following year. The ties so marked are then personally inspected by the district roadmaster and the general roadmaster, and, if approved by them, are renewed the following year, unless it develops when the ties are dug around preparatory to renewal, that any of them are still serviceable for another year or so, in which event such ties are left in the track. We use small extra gangs consisting of a foreman and 24 men for renewing main-line ties, which arrangement leaves the regular established section forces available at all times for maintaining the proper riding condition of the track."

R. H. Gaines, engineer maintenance of way of the Texas & Pacific: "Our practice is to have the section forces put in the ties. We have on the entire system only four extra gangs of 20 men each. We try to keep up tie replacements currently, and do most of the work with our section gangs."

Class II—Some Application of Group Renewals

The following roads, which from the nature of replies, commonly spot in ties, make group tie renewals in connection with surfacing work. It is the practice of roads in this group, when giving track a general lift, to renew ties in groups, replacing such ties as will not have a further service life of from two to five years. It is quite probable that some of the roads listed under Class 1 may properly be included in Class II. Comments of railway officers follow:

W. J. Backes, chief engineer of the Boston & Maine: "Starting in 1926 and finishing in 1930, about 600 track miles of stone ballast was installed on the Boston & Maine. Although during the first two years no definite effort was made to install more than a normal season's number of ties, the bulk of this ballast has been applied in track while making such tie renewals as will enable us to leave the track undisturbed for at least five years from the time the ballast was installed. Our program at the present time is to renew ties in this stone ballast territory once every five years, utilizing about 25 or 30 per cent of the ties which are removed during this installation in side tracks or branch lines for the remainder of their life. On two of these branches, during the present season, we are starting a program of tie renewals on one-half of each branch for a two year period, giving the track in which the ties are renewed sufficient tamping to carry it through for two years and making no tie renewals on the other half of the branch—the work being confined to spot surfacing. On the remainder of the road, it is our present practice to make tie renewals as required each year, the number of ties used being based on a spotting done personally by either the supervisor or his assistant."

J. C. Patterson, chief engineer maintenance of way, of the Erie: "On the Erie all tie renewals are spotted by the track supervisor and checked by the general roadmaster, during the months of March and April. In ordinary maintenance and tie-tamper work, all ties are removed from the track which will not last one year. On full ballasting and reballasting work, all ties are removed from the track which will not last two years."

W. S. Burnett, chief engineer of the Cleveland, Cincinnati, Chicago & St. Louis: "We make all our tie renewals with our regular section forces except where we may employ an extra gang on spacing after laying rail, or putting in a heavy lift of stone or gravel ballast, in which case the extra-gang puts in what ties are required. We do not postpone our renewals beyond normal life under ordinary conditions, although for the last few years we have been falling behind."

Earl Stimson, chief engineer maintenance of way of the Baltimore & Ohio: "It has been the practice to renew crossties when

The Use of Treated Ties Has Reduced Renewals

and as the service life of the individual ties has expired. Naturally, when track is being raised and surfaced, or when ballast renewals are under way, ties thus needing renewal are replaced. On branch lines and less important tracks which are not worked out-of-face some ties naturally remain that are kept in track beyond their normal life—the track condition being satisfactory for the service required. However, I should classify the work of track renewals on our system as being a spot renewal if a comparison is to be made with the group-renewal method which you suggest."

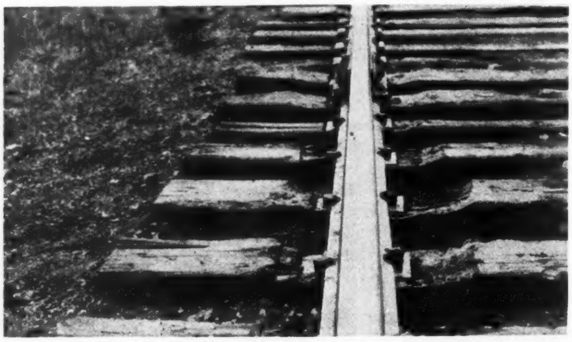
G. L. Sitton, chief engineer of the Southern: "Practically all of the crossties we apply are inserted by the section forces. If the track needs surfacing, and if money is available for such surfacing, it is given a light raise and is timbered so as not to require any additional ties for two years. At such time, we try to apply not more than six or seven ties per 33-ft. rail. After the two years has expired, we dig in from one to three ties per rail, when necessary, until the track requires surfacing again. We never follow the method of renewing ties out-of-face except through road crossings, station grounds, etc."

F. G. Jonah, chief engineer of the St. Louis-San Francisco: "The majority of crosstie renewals on our railroad are spotted in by the section gangs. In locations where we are surfacing out-of-face following rail renewal and also at other locations where a complete job of surfacing is being done by extra gangs, the tie renewals are taken care of in connection with the surfacing work, and here we usually take out ties that would or-

dinarily come up for renewal within the next two or three years, moving such ties as are serviceable to back tracks."

F. T. Beckett, engineer of maintenance of the Chicago, Rock Island & Pacific: "In our ordinary maintenance of way work, section men spot or insert ties and replace only those broken or unserviceable. Where we are doing ballasting of any considerable extent other than mere patchwork, we put in such ties as may be needed, and, of course, this is out-of-face work. The same applies to locations where rail is laid, the new track being put in shape and the ties inserted out-of-face. Other than this, we keep up our track by taking out failed ties only. The forces become trained to do a good job, and we hear little criticism of the so-called spotting-in method on the score that the ties are not being properly tamped in place."

H. R. Clarke, engineer maintenance of way of the Chicago, Burlington & Quincy, states that as a general rule ties are spotted in by the section forces. In ballast program work, ties are renewed in larger numbers, (or more in the nature of group renewals) by extra gangs, it being the general practice to replace ties that will not give service for two more years. Ties thus removed are reused in less important industry tracks.



The Use of Larger Tie Plates Is Eliminating this Type of Failure

A. A. Miller, engineer maintenance of way of the Missouri Pacific: "Section gangs make spot renewals, and extra gangs that do follow-up work after rail laying and out-of-face surfacing during ballast operations, make heavy renewals. Spot renewals on our railroad are now down to the level where the number inserted will average something less than one tie to the rail length, and where this condition obtains the ties renewed are spotted in rather than being surfaced in."

E. A. Craft, engineer maintenance of way of the Southern Pacific Lines in Texas and Louisiana: "It is the practice of this railroad, and the Texas, New Orleans, to have practically all tie renewals made by the section gangs, with the objective of getting the full life service out of each individual tie. At locations where out-of-face surfacing or ballasting work is to be done, tie renewals are left to the extra-gang forces and in such instances some ties are removed which under ordinary conditions would be left in track a year or so longer. Any ties so removed and found suitable are used again in light-service side tracks."

Class III—Group Renewals As a Standard Practice

Class III embraces the roads that group tie renewals as a standard practice. Under this method, track is not disturbed for four or five years, except as necessary to replace broken ties. This practice, while a newer one, is one which warrants careful investigation, and no doubt will receive very close attention on the part of maintenance officers. Comments on this procedure follow:

L. H. Bond, engineer maintenance of way of the Illinois Central System: "Normally, where we have rock and slag ballast, we do very little spotting of ties and follow the practice of handling tie renewals in connection with surfacing. In our gravel, cinder and chat track, spot renewals of ties are made, although even in this type of ballast we find it advantageous to make our tie renewals in connection with our surfacing—in fact, the size of the surfacing gang (we use the power tie tampers for most of our surfacing) depends upon the number of ties to be renewed. If tie renewals are light, only a few men work ahead of the machine; if tie renewals are heavy, the number of men renewing ties is increased proportionately."

G. T. Hand, chief engineer of the Lehigh Valley: "Extra gangs renew ties out-of-face (group renewal) in advance of raising, surfacing and applying renewal ballast. Ties that will not last until the track will require surfacing again are renewed at this time, and used in sidings or yard tracks. Track raised and surfaced in this way will hold up for four or five years without further attention. Section gangs make spot renewals in branch lines and yards as the condition of ties requires."

W. H. Penfield, engineer maintenance of way of the Chicago, Milwaukee, St. Paul & Pacific: "The practice on the Milwaukee is to have section gangs renew only broken ties in main tracks where the tie renewals are less than 200 per mile, and where they are not badly bunched. All other main-line renewals are allowed to accumulate until they are heavy enough to be handled economically by tie gangs. These gangs generally consist of about 75 men each."

Determining Tie Renewals

A matter of first importance in the renewal of ties is to determine just what ties need to be renewed, or just what ties, if left in the track another year, would by their further deterioration weaken the track to the point where safe operation is impaired. Methods of determining the further unserviceability of a tie generally start with the section foreman, who is checked by the roadmaster or supervisor, and other maintenance officers, so that ties generally are not removed until their full service life is obtained. Waste through excessive tie renewals is inexcusable, consequently tie renewals call for extreme vigilance on the part of the track forces.

Is it practicable to defer the renewal of a certain proportion of ties beyond their normal life in order to renew a larger number of ties at one time? Under the present changing conditions which impose new transportation problems, (and with these, changed transportation methods, higher speed, heavier axle loadings, more economical transportation, and lower maintenance costs) safe track must obtain at all times. It is the practice on many railroads to carry over tie renewals for a season or two in those locations where surfacing is proposed for the following season, making current renewals only to the extent that safe operation demands. The grade of timber used, and whether treated or untreated, also have a vital bearing on this problem, as a treated tie, with its increased life, makes it possible to defer renewals in stretches of track to an extent not possible with untreated ties. As the use of treated ties is extended, fewer tie renewals per panel and per mile are necessary, so that the deferring of renewals is more practicable at this time than in former years. This question is now in the minds of many maintenance officers, and is certain to receive continued attention.

Spot Versus Group Renewal of Cross Ties

Methods used in making tie renewals vary to some extent on the various railroads throughout the United States, because of differences of opinion among maintenance officers. At this time particularly (after four years of forced restrictions in maintenance work, in which tie renewals played a most important part) a new perspective is injected into the picture. Tie renewals have been confined to the requirements of safe operation. This rule applies also to rail renewals, ballasting and surfacing operations, in fact, to all items of maintenance. With improving conditions, we are again confronted with the question: Is it better to spot in ties or make group renewals on the basis of average life?

It is only natural that the method used will be subject to discussion, since the dominating factors are the

tie conditions and the percentage of renewals required, and the condition of the ballast and of other component parts of track structure. In earlier years, when untreated ties were used and renewals ran 400 or more per mile, it was not uncommon to renew 50 per cent or more of the ties in individual panels. In making such renewals where ballast was available, it was the general practice to give the track a raise sufficient to insert the ties without disturbing the old compacted bed. Today on a number of roads, particularly after rail relaying, where ballast conditions are good, it is the practice to give the track a light running surface, or sufficient to insert ties without disturbing the old, well-compacted bed, renewing enough ties so as not to require spot renewals for several years, other than perhaps an occasional failed tie.

Relative Merits of Spotting and Group Renewals

In the group renewal of ties, generally carried on in out-of-face surfacing, renewals are made at less cost per tie than when they are spotted in currently. It must be admitted that many ties renewed in accordance with such practices could see further service. In many instances, ties removed from track may have an additional service life of one, two or possibly more years if not disturbed. When removed and rehandled, the usefulness of a tie is somewhat impaired, and it may not last any longer than in its former location; in fact, the saving made in the reduced cost of renewal may be offset by a loss of material and the rehandling charge.

One great benefit to be derived from the group-renewal method is the uniform bearing of all ties that is secured since the renewal of larger numbers will necessarily carry with it a slight ballast lift. An additional advantage to be gained through the uniform bearing of all ties is a longer useful service life. Track will remain smoother for a somewhat longer period, as there is less disturbance. The less an old well-compacted roadbed is disturbed the longer the smooth-riding quality will obtain. One very noteworthy fact that has been rather generally observed during the depression years, has been the good riding condition of the track, in spite of greatly reduced maintenance. In a large measure this condition is no doubt due to the fact that track has not been disturbed as much as heretofore. Prior to the depression, considerable track was resurfaced each year, with an attending group renewal of ties, bringing the tie condition to a more uniform average, while during the last three or four years average conditions have been obtained with a minimum of spot renewals. While the decreased tonnage handled has been a contributing factor, lessened disturbance of track has been responsible, in large measure, for the good riding condition.

Under the group-renewal method may be listed the practices of many European railways, particularly those of England, France and Germany. On the railways of these countries, the permanence of construction and standards of maintenance are high, and it is the practice to renew practically the entire track structure (rail, ties, fastenings, etc.) out-of-face, utilizing material having further service life in secondary tracks. With a useful service life of 35 years per tie, the economy of such a procedure is readily seen, and no doubt at some time in the future, European methods will be more nearly approximated in the United States.

In special cases, where ties are not easily accessible for removal, it pays to renew them in groups, as for instance in street crossings, opposite station platforms, and in turnouts. Tie renewals made in groups result in less track disturbance for a longer period, but it must be remembered that when ties are renewed in groups, the track will necessarily reach a considerably weakened stage just prior to the time of renewal, unless the ties are renewed sooner than they should be. There can be no mistaking the fact that after a tie begins to fail—as is the case near the end of its service life—the failure is rapid, materially affecting the track structure and increasing the hazard of operation.

In deferring replacements awaiting group renewals, ties may deteriorate to the extent that track becomes rough, and in such instances it is a waste of labor to spend money for tamping, as such track will not stand up. Other arguments against group renewals of ties are that the expenditures must necessarily be heavier for the reason that the ballast requirements must be larger, the force allotments must be higher, the cost of ties in the aggregate must be increased, and during subnormal business conditions it is possible that operating accounts can not bear such charges. Furthermore, it may be that if tie renewals are deferred by the railroads collectively to a larger extent, by force of either necessity or practice, the number required in the aggregate will be greater and thus result in shortage of material for the demands on the

A Number of Railways Employ Tie Renewal Gangs

crosstie industry necessarily would be heavy, with a resultant reduction in the quality of the material produced, which would contribute appreciably to a reduction in the life of ties and a consequent increase in tie renewals.

The spot method of tie renewals has its advantages, as well as its disadvantages. Where no unusual condition obtains, the spot method appears to be the most economical. If a reasonable number of ties is renewed currently, the strength or firmness of the track structure remains more nearly uniform at all times. In the very nature of things, this is the condition most desired, for it is impossible to keep sound ties in track at all times except at great and unnecessary expense. Spot renewals of ties necessarily cost more per tie inserted than those renewed under the group method. If larger numbers are spotted in, the tendency is to cause rough track. Where such renewals exceed 300 or more ties per mile, it is advisable to have the ties surfaced in rather than dug in, whereas in the spot-renewal method only such ties are renewed as have no further service life. Spotting in ties is generally accomplished by section gangs that are regularly assigned to this work.

When replaced in that way, they are made progressively and promptly all over the railroad. Ties are replaced in the cooler seasons when labor may accomplish more and ballast is more easily worked. Also, ties are not strung out over as great a territory for so long a period. When inserted by section forces there is the tendency to see that work is done in a more thorough manner, as the foreman in the final analysis, is responsible for a given stretch of track, and it is to his advantage to see that work is done thoroughly.

Conclusions

In the study of Spot Versus Group Renewal of Gross Ties, the committee has endeavored to set up the relative advantages of both methods, it being the opinion that both methods are desirable, and have their place in track maintenance.

The tie-renewal methods now in use on 33 of the leading steam railways of the United States form the basis of an interesting study, and the committee is indebted to the maintenance officers of these railroads for answering the inquiry as to the practices in their respective territories.

In the opinion of the committee:

Ballast conditions, riding qualities, maintenance upkeep, and the general physical condition of the track structure, are prime factors in determining the proper method of correcting conditions and in making tie renewals. There should be no questioning the fact when ballast becomes foul, track center-bound, and maintenance upkeep heavy that a program of light surfacing is necessary and that it carries with it the necessary tie renewals to the extent that the surface should not be disturbed for several years.

Ties inserted by the group-renewal method are applied at less cost per tie renewed than an equal number of ties spotted in.

Inserting ties by the group-renewal method, with a slight ballast lift, results in a more uniform tie bearing, with a consequently smoother track for a certain period of time.

Track will not be as strong under the group-renewal method just prior to the periods of renewals, because ties have been permitted to deteriorate in larger numbers. This deterioration of the tie structure affects the life of rail and rolling equipment adversely, and increases operating hazards.

Group renewals of ties should be made in connection with all surfacing programs, where a slight ballast lift is made.

Ties inserted by the spot-renewal method cost more per tie renewed, but in many instances the increased cost per unit is more than offset, since that fewer ties are renewed, by the fact that when an old tie is given a new bearing, it will not perform its function as it would if the bed had been left undisturbed.

A longer useful service life of ties will be obtained under the spot renewal method, as the group renewal, to be carried out effectively, will result in the removal of many ties that would have several years effective life, if undisturbed. The full service life of the individual tie is obtained only through the spot-renewal method.

Ties spotted in track in larger numbers have a tendency to cause rough and choppy-riding track.

Track is stronger at all times when ties are spotted in, as the foundation is more nearly at an average condition.

More uniform track forces obtain where the spot-renewal method is used.

Ties renewals by the spot method are made progressively and uniformly over the entire railroad.

Tie renewals during the depression years have been deferred to some extent; the track structure, in many instances has deteriorated in strength, and on account of this, together with the retrenchment in ballast and rail programs, it is only natural to assume that with improved business conditions the track structure must be strengthened. This condition will naturally bring about renewals in larger quantities, and in so doing the subject of tie renewals will assume greater importance. While it is desirable to keep the track structure at an average condition at all times, it is the thought, as stated above, that this has not been done in many instances owing to the restrictions imposed. Heavy tie renewals will have to be made for several years in many locations, and it appears that these may be made more economically by the group-renewal method. After having been brought up to a good condition again, a normal rate of tie renewals should obtain for some time, and particularly so, because of the use of treated material.

Railroads having multiple tracks are subjected to difficulties, as the ramifications of tie renewals in these territories are varied, local conditions governing the method used.

It is the thought of the committee, that the subject is one deserving the attention and study of all maintenance officers.

Committee: E. H. Piper (Chairman), train master, C. B. & Q., McCook, Neb.; C. F. Allen, roadmaster, C. M. St. P. & P., Milwaukee, Wis.; R. H. Carter, supervisor, I. C., Chicago; P. J. McAndrews, roadmaster, C. & N. W., Sterling, Ill.; L. Coffel, supervisor of track, C. & E. I., Momence, Ill.; R. S. Gutelius, general roadmaster, D. & H., Carbondale, Ill.; R. H. Milliken, roadmaster, C. P. R., Trenton, Ont.; M. Donahoe, division engineer, Alton, Bloomington, Ill.; E. P. Safford, supervisor of track, N. Y. C., Silver Creek, N.Y.; L. E. Crance, supervisor of track, C. & O., Clifton Forge, Va.

Discussion

J. P. Corcoran (Alton) did not favor removing ties that will last from two to four years. He favored spot renewals, but called attention to the fact that in most cases where rough track results from this class of renewal, it is because proper care is not exercised in trimming the old bed down to accommodate the greater depth of the new tie, as compared with the one removed. W. H. Sparks (C. & O.) said that the method to be followed in making tie renewals depends in large measure on roadbed conditions. If the ballast is clean, it has been his experience that ties can be spotted in without making the track rough, but that this requires care in the preparation of the bed. He said also that where large tie plates are in use a tie that has practically exhausted its service life will last considerably longer than a similar tie not equipped with tie plates. Ties generally last longer today than they did 10 or 15 years ago, largely because the roads are following more closely the standard tie specifications and are, therefore, getting better tie timber and larger ties. With these conditions, the spotting method of tie renewals gives a more uniform track condition, with respect to both strength and riding qualities.

T. Thompson (A.T. & S.F.) stated that current tie renewals on his territory are running about two to three to the rail and that where renewals are no heavier than this, it would be unreasonable to raise track merely to get this number of ties in. He was also of the opinion that track will not get rough if the proper care is used in preparing the roadbed and in doing the subsequent tamping. On the other hand, if the ties are allowed to remain in the track until group renewals are necessary, the track is very definitely weakened.

F. B. Lafleur (S.P.) stated that on his road it is not customary to take out ties that will last another year. In many cases where old ties are removed, it is found that they are plate cut or decayed on the bottom so that the depth of the new tie is greater than that of the tie removed. To overcome this difficulty, the old bed is removed to the proper depth to accommodate the new tie, which is tamped to bring it to the correct surface, after which the tie plate is inserted and the tie is allowed to settle under traffic. L. M. Denny (C.C.C. & St.L.) said he preferred to make spot renewals because it is difficult to get a group of ties to support the track at the

proper elevation until they have been tamped two or more times. This difficulty is not experienced with group renewals where general surfacing is done because all ties have equal bearing.

G. T. Donahue (N.Y.C.) stated that in his territory ties are not being spotted in because it is believed that out-of-face renewals give more resilient track. After the ties are renewed, the track is given a running surface without being raised. Spotting is employed only on yard and side tracks. E. P. Safford (N.Y.C.) stated that in his territory tie renewals are made out-of-face only in connection with the laying of new rail and ballasting, but his experience has indicated that under other conditions the group renewal method is distinctly a waste of money because there is considerable loss in tie life, while the cost of replacing the old ties that still have some service life is excessive as they will last in their new location only two to four years.

William Shea (C.M.St.P. & P.) explained the method followed on his road of renewing ties with gangs aggregating 75 men. All ties are distributed on motor cars and trailers by the local section forces and are laid down at right angles to the track at the exact point of use. The internal organization of the gang itself is highly specialized, for the purpose of eliminating lost motion in connection with the various operations that must be performed. From January 1 to August 31 of this year, 1,070,000 ties were inserted by 20 gangs at a total cost for labor only of $0.1329 per tie. In addition, the cost of surfacing is $16.52 per mile and lining $17.59. The total cost of all items, including the application of tie plates and rail anchors and the use of work trains to move camp outfits, has been $107.95 per mile and the average renewals for the system 422 ties per mile.

J. B. Martin (N.Y.C.) questioned the statement in the report that heavier rail sections will permit a wider spacing of ties. Several members supported Mr. Martin and L. M. Denny (C.C.C. & St.L.) moved the deletion from the report of the reference to wider spacing, which motion was carried.

The Conservation of Rail

Report of Committee

A. A. Johnson
(Chairman)

RAIL renewal is one of the large items of expense on all railroads, and all practical means should therefore be used to extend the life of rail. The committee has outlined below some of the principal methods by which this may be accomplished.

Mill Practice

Inspectors employed by the railroads should be experienced and alert. Constant efforts should be made to see that the best mill practices are used, from the furnaces to the finishing. The quality of scrap used in each heat must be watched closely. Much care must be used to see that rail ends are perpendicular to the longitudinal axis and free from burs. Careful tests and inspection must be made to detect any internal defects or surface imperfections. Constant cooperation should be maintained between the railroads and the manufacturers to improve and correct mill practices.

Chemical Properties—The life of rail under the different traffic conditions depends to a large extent on its chemical composition. If the carbon content is too low, the metal in the top of the head will flow badly; an excess of carbon may cause brittleness. Experience has developed certain chemical compositions which have been found to be reasonably good, and these should be adhered to in the manufacture of rail until better proportions are found.

Cooling—Many tests have been made in recent years of the practice of retarding the cooling of rail in ovens rather than on the hot beds. This is done to reduce the severe internal stresses set up in cooling the larger rail sections, which product thermal cracks and may result in rail failures under traffic. The indications are that the newer methods of cooling may be beneficial, although further experience is desirable.

Heat Treating—Considerable attention has been given to a study of the heat treating of rails at the mill for the purpose of producing a harder surface and thus reduce the amount of abrasion and distortion of the head under traffic. Some railroads report that benefits are derived from such treatment, but this process has not yet been placed in general use.

Rail Laying

Rail should be laid to the proper gage. If it is laid slightly tight, the wheel flanges will abraid the head badly. Great care must be used to adz the ties properly so that uniform bearing will be provided. If the bearing is not uniform on successive ties, the gage will be poor and the rails may be bent or broken. Where old tie plates are removed and the ties are adzed, one line of rails should be relaid at a time, and a few slow-speed trains should be allowed to pass over the new rail in order to bed the plates, before the opposite side is laid. Any inequalities in gage should be corrected after the plates have settled.

It is very important to avoid surface bending the new rail. Low spots and loose ties should be shimmed, or preferably tamped, as soon as the rail is laid. General raising, tieing and surfacing should follow rail renewals immediately.

Proper expansion between the rail ends is an important requisite for the protection of the rail and for the safety of traffic. A thermometer should be used to determine the proper expansion. In many instances, rail that is laid too tight develops kinks in the quarters, which result in poor gage and alinement, both of which are detrimental to the rail. Some railroads have found it beneficial to chamfer the rail ends at the top of the head with power grinders as soon as the rails are laid to prevent end overflow and chipping, in the event that the rail ends come in contact with each other by reason of expansion or creeping.

It is generally conceded that rail should be canted inward and this can be provided for by using canted tie plates. If canted plates are not available, a cant may be

produced by proper and careful adzing of the ties. Tie plates with a cant of 1 in 40 are commonly used, although a cant of 1 in 20 is preferred by some railroads. Tie plates are very effective in maintaining proper gage, and thus preventing the rail from becoming line kinked. It is important that plates of the proper dimensions be provided in order to gain the maximum benefit from their use. They should have the proper length and eccentricity so that they will embed evenly on the ties and thus prevent the rail from canting outward.

It is essential that good joint appliances be used in order to prevent damage to rail ends so far as possible. Heat-treated bolts are used on many railroads, as they eliminate stretch to a large extent. The bars should be carefully rolled and have sufficient draw to take up wear. Some railroads use spring washers while others do not.

The Maintenance of Rail

The life and usefulness of rail depends largely on the care it receives at the time of laying and during the time it is in track, and the maintenance of surface, line and gage is of the first importance. Too much emphasis is sometimes placed on the quantity of work accomplished

Care in Laying Is an Important Factor in Rail Conservation

and not enough on the quality. First-quality workmanship in laying and first-class maintenance will add materially to the life of rail and will prove most economical in the final analysis.

The crossties should be reasonably good, properly spaced and adequate in number to carry the traffic. If there are many poor ties or wide spaces between good ties, the rails will become surface bent or break. Good rail will soon be ruined if suitable ballast of the proper depth, and a stable and well-drained roadbed are not provided, regardless of the amount of labor applied.

Improper bolt maintenance results in rapid damage to joint bars and rail ends. Consequently, it is important to provide a routine program for the maintenance of the proper bolt tension.

A sufficient number of anti-creepers should be applied to prevent creeping of the rail. If an insufficient number is applied, the ties will shift in the ballast and the surface, line and gage will be disturbed, thereby producing conditions that are detrimental to the rail.

Sharp curves should be equipped with lubricators to prevent flange cutting of the high rail, and thus extend its life. Lubrication also preserves the gage and retards the destruction of the low rail.

Wear of the rail ends and the joint bars on the fishing surfaces seriously impairs the proper functioning of the splice bars and results in damage to the rail ends. This condition should be watched closely and, as soon as it is found necessary, the worn bars should be replaced with built-up, reformed or slightly oversized new bars. This is economical as it will prolong the life of the rail and also reduce maintenance charges. Old bars can be reformed or built up economically. In some instances reformed and built-up bars have been slightly crowned at the top center to compensate for the wear on the under side of rail heads. Difficulties are experienced, however, in obtaining the correct amount of crown to fit all rails. Some railroads report that wear on the top and bottom of joint bars and at the fishing contacts on the rail is greatly retarded by lubricating the joints every year or two with pressure oilers.

Rail-End Welding Calls for Careful Planning

Battered rail ends can be built up economically in track by electric arc or oxy-acetylene gas welding. After welding, the added metal can be dressed to a true surface by grinding machines. Rail in track should be watched closely in order to determine when the building up should be done. Work of this character requires a well-planned program to get the best results. The life of the rail and joint bars can be extended materially by this process.

The ends of new rail may be heat-treated in track by applying heat to the top surface for a distance of from two inches to three inches from the joint and quenched to obtain the desired hardness. Either electric or gas heat can be used. It is recommended that the heat treating be done after the new rail has been under traffic about one week. However, one railroad reports that it heat-treats the rail before traffic is permitted to pass over it. The object in heat treatment is to prevent end and lateral flow of the metal at the rail ends and thus retard the development of batter. Experience thus far would indicate that this process has merit and is worthy of further study and test.

Grinding to Overcome Variations in Height

New rails coming from the mill vary slightly in height, and some railroads have used reciprocating grinders to dress the top surfaces of adjacent rail ends to exactly the same height, thus eliminating the impact that is produced when wheels pass from a higher to a lower rail or the reverse. This impact has a tendency to distort the rail ends.

Rail which has been badly battered and bent at the ends can be made serviceable by cutting off the damaged portions. This results in considerable waste of metal, produces many odd lengths of rail, and is expensive as it entails either a heavy outlay for loading and unloading and for transportation to and from the rail-saw plant, or the costly process of cutting and drilling the rail in the field.

Rerolling, which reduces the section to about 90 per cent of its original weight, produces rail of good line and surface, but it has disadvantages, as, for example, the rerolling charges, plus the handling and freight make the cost rather high. Rerolling also has a tendency to enlarge any defects that existed in the rail when it was removed from the track.

The life of rail is seriously impaired in some instances by equipment. Improperly counterbalanced locomotives and locomotives of the heavier type when operated at excessive speed overstress and kink rail badly.

Committee: A. A. Johnson (Chairman), engineer m. w., D. L. & W., Hoboken, N. J.; W. Constance, supervisor, C. & O., Barboursville, W. Va.; W. F. Monohan, general inspector, S. P., San Francisco, Cal.; W. O. Frame, district engineer maintenance of way, C. B. & Q., Burlington, Ia.; J. B. Martin, general inspector of track, N. Y. C., Cleveland, Ohio; F. A. Tranzow, superintendent of track, G. T. W., Detroit, Mich.; I. H. Schram,

engineer maintenance of way, Erie, Jersey City, N. Y.; J. B. Kelly, general roadmaster, Soo Line, Minneapolis, Minn.; B. E. Haley, general roadmaster, A. C. L., Lakeland, Fla.

Discussion

Much of the discussion of this report centered around the results obtained with reformed angle bars, over-sized bars and rail joint shims. L. M. Denney (C.C.C. & St.L.) stated that he had obtained better results with reformed bars than with over-sized bars. H. R. Clarke (C.B. & Q.) stated that the use of shims has proved more economical on light-traffic branch lines than either reformed or crowned angle bars but that the shims had not proved satisfactory on high-speed, heavy-traffic lines. In discussing the relative merits of crowned and uncrowned reformed bars, Mr. Clarke pointed out that if the relaid rail is to be used without cropping, crowned bars should be provided to compensate for the wear in the fishing surfaces but if sawed rails are being laid, bars of uniform section should be provided. This opinion was endorsed by J. B. Martin (N.Y.C.).

W. E. Carter (B. & L.E.) reported excellent results with sawed rail equipped with heat-treated oil quenched reformed bars. W. L. Roller (C. & O.) stated that he had obtained good results by replacing worn joint bars with head-free bars and in other cases by equipping the old bars with rail joint shims, and insofar as he could tell, the results obtained were about the same. Chairman Johnson said that it was his experience that the use of head-free bars on relayer rail was advantageous only in those cases in which the wear on the fishing surfaces was not excessive. William Shea (C.M. St. P. & P.) also reported good results with reformed crowned bars, stating that it was the practice on his road to crown the bars 1/32 in. on top and 1/64 in. on the bottom, it being his experience that the bottom crowning is also important.

B. E. Haley (A.C.L.) said that almost anything that is done to the joint will help, if it is done right. For example, if rail joint shims are to be used, care must be taken to insure that the right thickness of shim is provided and if this is done, good results will be obtained. Mr. Haley reported excellent results with reformed bars. Good results from reformed bars were also reported by Walter Constance (C. & O.), who said that his road was reforming bars economically in a plant equipped with a forging press. W. H. Sparks (C. & O.) questioned the advantage cited by Mr. Shea of providing a crown on the lower fishing surface of reformed bars.

Highway Crossing Construction

Report of Committee

J. J. Davis
(Chairman)

UNUSUALLY keen competition in the transportation field has prompted the railroads to exert every effort to attract business and to promote a more friendly attitude on the part of the public. One very definite way to defeat such an attitude is to provide rough, unsafe, and poorly constructed grade crossings. In this field the maintenance of way department can either co-operate, by providing grade crossings of such character as to attract favorable comment, or bring down upon their railroads the wrath of the driving public, which includes many shippers. Nearly all of us are familiar with certain rough grade crossings that we would somewhat shamefully admit were a part of our railroad, or on which we would hesitate to place the name of our railroad conspicuously. The comments of a back-seat passenger who cracks his head against the top of the car in going over a railroad track are not fit for publication. If this same passenger happens to be a shipper, he will enjoy meeting the traffic representative of that railroad on his next visit, with resulting embarrassment to all concerned.

The construction of highway grade crossings has become one of the ever increasing problems to be faced by maintenance of way forces. This problem has grown from a relatively unimportant factor in maintenance to one that not only represents a considerable expenditure but requires careful supervision and planning, and in which the public has become much interested and exceedingly critical. Before the day of paved highways and motor vehicles, the requirements of a grade crossing meant very little. The speed of highway vehicles was scarcely considered, and repairs to these crossings were inexpensive and easily made. It is quite obvious that the improvement in highway crossing design and construction has not kept pace with the traffic and speed of the vehicles that are now using them.

Growth of Motor Traffic

The rapid growth of the motor vehicle is shown by registration statistics. In 1900 there were approximately 8,000 motor vehicles, the number increasing to a peak of 26,545,000 in 1930. Along with the rapid increase in numbers, there has also been a corresponding increase in speed and wheel loads, and a continually increasing mileage of improved roads. As evidence of the increase of commercial vehicles, trucks and buses, more than 17 per cent of the motor vehicle production in 1932 was of this type. The railroads in this country are now maintaining approximately 238,000 grade crossings, the construction of which has required a heavy investment and heavy annual expense for maintenance.

The May, 1933, issue of *Railway Engineering and Maintenance* contained a resume of the experiences of railway engineers with existing types of grade crossings, clearly indicating the confusion and lack of agreement as to the best type of construction for the heavy traffic that these crossings are required to carry. Many railroads which have standards for highway crossings are not following them, while others are constantly experimenting with various types, all with the express purpose of finding a design that will meet the requirements of present-day highway traffic and that will offer the least restriction to track maintenance. The continually increasing demand for greater speed in railroad traffic will require still further refinements in line and surface, all of which will have their effect upon a design of crossings that will permit the correction of defects in track through them with the least restriction.

There are many variables which must be considered in selecting the proper type of crossing for any particular location. The more important of these variables are:

1. Railroad traffic density and speed.
2. Highway traffic density and speed.
3. Permanency of the highway construction.
4. Location of the crossing.
5. Condition of the subsoil and drainage.
6. Possible change in design of the track structure.
7. Availability of crossing material.
8. Cost of the crossing on an annual basis.

If the traffic on the railroad is very light and moves at slow speed, and the traffic on the highway is very heavy and fast, a type of crossing which is permanent in character may well be selected, without giving a great deal of consideration to the restrictions which that type of crossing may offer to track maintenance. If, however, the reverse of this situation exists, a type of crossing which will offer the least possible restriction to the maintenance of good line and surface for heavy, high speed, railroad traffic should be selected. All of the other variables will require consideration in the selection of the best type of crossing for a given location.

This Type Is Economical for Crossings of Very Light Traffic

The final and most important determination to be made is the cost of the crossing on an annual basis. To arrive at this conclusion, all of the elements of cost must be included, although some of them will have to be estimated. The initial cost per square foot can be quite accurately estimated, and from this the carrying charges can be computed. The life of the crossing, as well as the maintenance, must be estimated and from these the cost per year may be approximately determined.

The Types of Crossings

The types of crossings now in most common use are:

Untreated plank.
Treated plank.
Bituminous concrete.
Preformed asphalt plank.
Precast concrete.
Monolithic concrete.
Metal (rolled or cast).
Armored (rail-type).

Some of the more apparent advantages and disadvantages of the various types of crossings are listed:

Type	*Advantages*	*Disadvantages*
Untreated Plank	Low first cost Easily removed Easy to install Can be made to fit any design of crossing	Short life due to decay Liability of plank to become loose and be caught by dragging equipment Frequent maintenance
Treated Plank	Moderate cost Ease of installation and removal Can be adapted to any design of crossing Comparatively long life	Subject to moderate wear Moderate maintenance
Bituminous	Moderate cost Can be adapted to any design of crossing Easily repaired Will not be greatly damaged by dragging equipment Long life	Requires maintenance in patching worn areas Difficult and expensive to remove for repair of track or correction of line and surface When necessary to remove, very little can be salvaged
Asphalt Pre-formed Plank	Moderately long life Easy to install and remove Comparatively low maintenance	High first cost Rather difficult to remove without damaging
Pre-cast Concrete	Long life Low maintenance cost Can be removed and replaced without damage	High initial cost Heavy to handle
Monolithic Concrete	Long life Low maintenance cost	High first cost Expensive to remove to repair track No salvage when removed to repair track
Metal—Rolled or Cast	Long life Low maintenance cost Can be removed and replaced without damage	High initial cost Requires some attention to keep tight and noiseless Requires special fittings to make repairs when damaged
Armored (Rail type)	Long life Material usually available Can be removed and replaced without much damage to materials Low maintenance	Relatively high first cost Expensive to remove and make repairs to track Cannot be handled with small force

Information furnished by various railroads having crossings in service of the types listed, indicates a life as follows:

	Estimated Life—Years		
Type of Crossing	*Minimum*	*Maximum*	**Average*
Untreated plank	5	6	5.2
Treated plank	6	18	10.6
Bituminous	3	22	6.9
Asphalt plank	15	20	15.4
Concrete—precast	12	40	18.6
Metal—rolled—cast	10	25	17.5
Armored (rail type)	3	10	6.2

*Average is based upon all replies estimating life of crossings.

Careful Preparation Necessary

The first consideration in the installation of any type of crossing will obviously be the thorough preparation of the track structure. The first requisite in providing good track is adequate drainage, and this is even more important at grade crossings. Surface ditches should be constructed to carry the water away from the crossing, and where subsoil conditions warrant, subdrainage should be provided to insure against water pockets or soft spots developing in or adjacent to the crossing.

If the track is not well ballasted or the condition of ballast is not the best, it should be dug out well below the bottom of the ties and, where possible, two feet beyond the ends of the ties for the full length of the crossing and far enough on each side to insure uniform bearing and adequate drainage throughout the crossing area. The track should then be reballasted with good clean ballast, preferably crushed rock, slag, or their equal.

All ties should be sound treated ties, carefully spaced to provide even bearing. Sawed ties should be used where the type of crossing requires them. Because of the additional loading on this portion of the track from highway traffic, it is recommended that the ties be spaced closer through the crossing than is standard in the track adjoining the crossing, in order to increase the bearing on the ballast and the roadbed and reduce the settlement within the crossing.

The rail throughout the crossing should be either new rail or usable rail of full section. If the rail at the location of the crossing is not of the section adopted as standard in that territory, it should be changed to the standard section through the crossing and for at least a rail length on each side. The rail should be continuous through the crossing, this condition being met either by welding the joints or by the use of special length rail where required.

Tie plates, preferably new or at least of full section, should be placed on each tie. The track should be full spiked to perfect gage and brought to good line and surface. The tamping should preferably be done by mechanical tampers, but should at least be done carefully and solidly to insure the most uniform and solid bearing. If it has been necessary to dig out ballast well below the bottoms of the ties, it is a good plan, where possible, to allow trains to compact the ballast before bringing the track to final level and surface.

On many occasions the railroads have spent considerable money to provide a good crossing, only to have the smooth-riding qualities defeated because the pavement was not brought to a level coinciding with that of the track. Where an improved highway has been installed prior to the construction of an improved type of crossing, a crown is sometimes left in the street or highway where it meets the track. Such a condition can usually be overcome by seeking the co-operation of those in charge of highway construction or maintenance. In nearly all cases such co-operation is readily given and only requires a mutual understanding of the benefit to the driving public.

The earliest and simplest type of grade crossing consisted of gravel, cinders or dirt filled between the rails. This type of crossing was greatly improved by the addition of a plank outside and inside of each rail, the outside plank being set against the rail, and the inside plank far enough away from the gage side of the rail to provide a flangeway. Many crossings of this type are in use today on highways carrying very light traffic, and in such locations are economical and sufficient.

Plank Crossing—Treated and Untreated

While there has been a decided tendency on the part of many railroads to replace plank crossings with some more permanent type of construction, the number of plank crossings still greatly exceeds the combined number of all other types in use today. In considering the merits of the plank crossing it must be remembered that the crossings embraced within this classification range all the way from the primitive type in which a single unsized, untreated plank is provided on each side of each rail, as described above, to the type in which carefully selected, sized and treated planks are installed in accordance with a carefully developed plan that calls for a high class of workmanship. Only a limited proportion of all plank crossings fall within the limits of what may be designated as high-grade construction.

It may safely be said that the average plank crossing receives the least amount of care in installation, and the least thought in design and planning, of all of the types employed, and yet is the most common in use. If this type of crossing receives the proper care in the selection of materials and close supervision in installation, the cost of such a crossing, on an annual basis, will compare favorably with other types and in many cases will prove more economical. Many railroad engineers are of the opinion that the plank crossing, if properly constructed with good materials, provides the best construction, all phases of the crossing problem being considered.

Untreated plank was for many years the accepted material for important grade crossings, and principally because of its low first cost, it is being used to a large extent today, but is rapidly being replaced by treated plank or one of the more permanent types of crossings. The labor required for installing untreated plank is little, if any, less than that required for treated plank, so that on an annual basis, particularly where treated ties are used, the saving in first cost disappears because of the greatly increased life due to treatment.

The preparation of the track structure should be made as previously outlined, care being taken in all of the details. The planks should be surfaced one side and one edge to provide uniform thickness and width so that no trimming will be required in the field to insure that the planks fit snugly between the flange rails or special flange guards. After seasoning and proper framing, the planks should receive an approved preservative treatment to insure maximum life. Creosoted red oak, or black gum planks, 4 in. by 10 in. by 16 ft., provide about the best material for such use, and if properly installed, will

A Creosoted Plank Crossing

amply pay for the added cost of this class of material in improved wearing service.

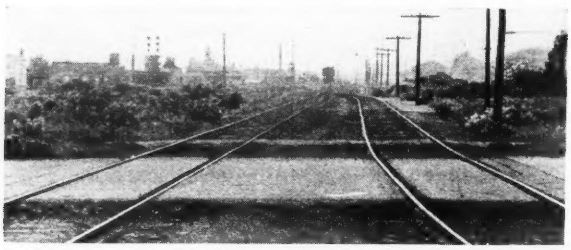
It has been, and in many cases is today, the practice on some railroads to use almost any material available for shims to bring the plank level with the top of rail. Old fence boards, old grain doors, or any other material of about the right thickness has been used for this purpose and therein lies much of the cause for condemning the plank crossing. One of the most important requisites for the permanence of a good surface on plank crossings, as well as on the most elaborate types of permanent crossings, is a uniform bearing. Shims should be made in suitable lengths and surfaced on one side to the exact thickness required to bring the plank level with the top of rail, depending upon the section of the rail, the thickness of the tie plates and the plank in use. These shims should be treated and in all respects provide a service life equal to that expected of the treated plank. Each tie should be fitted with a shim, securely nailed in such a way that if splitting should occur, the shims will not work out from under the plank.

A flange rail or special type flange guard should be applied and securely supported in place before the planks are laid. The planks should be laid so that the ends

join on a tie, if the crossing is more than one plank in length. Planks should be fastened by boat spikes or lag screws; in either case the planks and shims should be bored to prevent splitting. If boat spikes are used, they should have a penetration in the tie of at least four inches and should be fitted with flat washers under the head to provide increased bearing on top of the plank. Planks should be spiked at each end and on at least every second tie. In very heavy-traffic crossings, the planks should be spiked on every tie, the spikes to be driven with the chisel point across the grain of the tie. At both ends of the crossing, the planks should be bevelled to prevent dragging equipment from catching.

Bituminous Crossings

Bituminous crossings have proved their merit and have become recognized as one of the types that lend themselves to economical maintenance. In the selection of this type of crossing, as previously pointed out, con-



A Bituminous Crossing

sideration must be given to the stability of the roadbed, as it affects the necessity of disturbing the track to maintain the required refinement of line and surface. This is apparent when it is realized that any work of this character on the crossing immediately defeats the economy which would otherwise result from the use of a crossing of this type. Where the characteristics of a crossing lend themselves to this type, it will be found to have many advantages if properly constructed. It is not expensive in first cost, can be installed without skilled labor to produce a smooth-riding crossing, and with a small amount of material and labor can be kept in first-class condition until it becomes necessary to rebuild or repair the track structure. The selection of this type of crossing, therefore, resolves itself into a determination of the probable length of time, under known traffic conditions and the presumed stability of the roadbed, that the track structure may be left without disturbing it.

After the track structure has been placed in proper condition, the ballast should be dug out to the bottom of the ties to receive the bituminous concrete material. The aggregate should be of clean crushed rock or gravel, graded from 1 in. to 2½ in. in size for the foundation or lower course. The amount of bituminous binder to be used should be increased as the material approaches the crossing level; at the bottom it need be only sufficient to allow the aggregate to be tamped solidly in place and prevent the material from moving. This size of aggregate should be used until the bituminous concrete is at a level approximately two inches below the top of rail. The remaining two inches should have a sufficient amount of bituminous binder to coat thoroughly each particle of aggregate, which for this wearing surface should be of ¼-in. rock chips or gravel.

The use of natural rock asphalt, or a synthetic rock asphalt material such as has been placed on the market in recent years, provides an unusually fine material for the two-inch wearing surface, where the foundation has been constructed as outlined above. This material can be shipped in open-top cars, ready to apply, and can be stocked successfully for a considerable length of time, for repairs when needed. The material is easily applied and can be tapered out to a feather edge in smoothing depressions in the crossing as they occur. The completed crossing presents a compact surface which is smooth, resilient, non-reflecting and nearly skid proof.

Preventing Damage by Vibration

The occasion for the early repair of bituminous crossings usually results from vibration or movement of the running rails. This movement of the rails causes a crumbling of the material next to the rail, particularly during cold weather when the resilience of the material is low and it has become more or less brittle. To overcome this condition, some railroads have adopted the plan of placing a rail on each side of the running rails, the rails being of the same section and laid "workways." This obviously affords greater protection for the material from the effects of the wave motion and vibration of the rail, and eliminates this troublesome condition to a great extent. A flange rail or special flange guard is preferred by some railroads for use on the gage side, using a supplemental rail only on the outside. One railroad that uses the three-rail construction reports the use of special tie plates made for this purpose.

In crossings of this kind, it is always good practice to use a richer mixture, with the finer aggregate next to the rails in order to provide more resilience. The success of bituminous crossings depends largely upon the care taken in providing a well-compacted foundation, using sufficient asphaltic material to bind the aggregate. The practice of building these bituminous crossings above the level of the rails to allow for settlement frequently results in a rough riding crossing. It is far better to build the crossing to the correct level and, after the material has compacted under traffic, bring the crossing to perfect level by the addition of material used for the wearing surface. One of the important advantages of this type of crossing is that it practically prevents water from getting into the track structure.

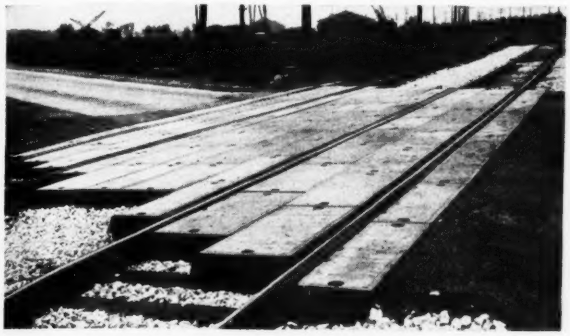
It is the practice of some railroads using treated plank crossings to build them with the top ¼ in. to ⅜ in. below the top of rail, and place a wearing surface of rock asphalt or other bituminous material on top, thereby not only preventing wear on the plank, but increasing the waterproofing of the plank crossing. In order for this method to be successful, the planks must have a very uniform bearing and be securely fastened to prevent movement. Another important use of bituminous material is in the intertrack spaces of multiple-track crossings. Regardless of the type of crossing that may be used in the track proper in such locations, this class of material is ideal for this purpose.

Preformed Asphalt Plank

The use of asphalt plank as a wearing surface for grade crossings produces a smooth and somewhat resilient type of crossing. Because of lack of structural strength of the material, it is laid on a timber deck of the height necessary to bring the top of the asphalt plank level with the rail. The timber deck is laid parallel with the rail and fastened to the ties by lag screws. The plank is ordinarily 2 in. thick and from 8 to 10 in. wide, being nailed to the timber deck, with a small washer under the head of the nail.

Precast Concrete Slabs

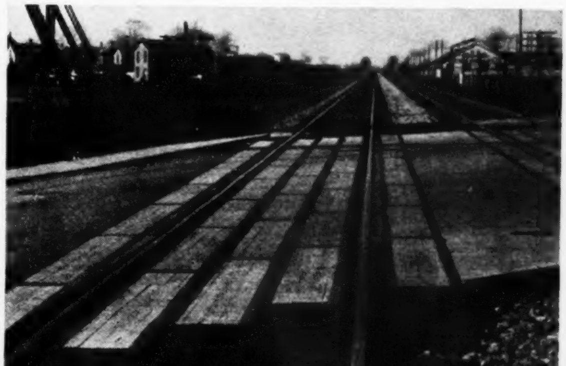
The introduction of precast concrete for grade crossings followed closely the use of concrete for the paving of highways. Many of the original designs for slabs proved to be poorly suited for this purpose. Better reinforcing of these slabs, together with an armored protection of the edges, has eliminated many of the early failures caused by breakage and crumbling. Some railroads have their own designs and construct the slabs with their own forces. Others are using patented types,



A Concrete Slab Crossing

which can be purchased in any desired thickness to accommodate the height of rail in use. Descriptions of the more common types of slab crossings on the market are given in the following:

Weltrus Type—The Weltrus type crossing, manufactured by the Truscon Steel Company, Youngstown, Ohio, provides a welded form with a concrete filler. The forms are purchased from the manufacturer and filled with concrete by the railroad. The forms provide protection of the concrete on all corners and edges. The reinforcing provided to carry the loading is all of



Another Type of Concrete Crossing

copper-alloy steel, electrically pressure welded. The standard sections are made 16¾ in. by 6 in., by 6 ft., long, although they can be furnished in any required dimensions. No fastenings are used in securing the sections in the crossing, the units being simply laid in place.

Permacrete Slab Crossing—The Permacrete crossing, manufactured by the Permanent Concrete Products, Inc., Columbus, Ohio, consists of reinforced concrete slabs, protected on the top edges by 1¾-in. channels. These slabs are furnished in standard sizes 16¾ in. in width, 6 ft. in length and in thicknesses of 5 in., 5½ in., 6 in., 6½ in., and 7 in., and may also be secured in special sizes or shapes to fit special conditions.

Massey Armored Slabs—Armored concrete crossing slabs constructed by the Massey Concrete Products Corporation, Chicago, differ considerably from those already described. The slabs are made in standard sizes, 16¾ in. by 4 in. by 4 ft. 6 in. A frame of structural steel channels completely protects the edges and corners. The slabs are further reinforced near the top and bottom with cold drawn wire fabric. These slabs, when in place, are supported only at each end, wood shims being used only on the supporting ties. The slabs are held in place by ⅝-in. by 10-in. lag screws, one at each end of the slab, provision being made for these lag screws in the design of the slab.

Monolithic Concrete

Certain side-track crossings carrying a very light railroad traffic, but having a stable roadbed, may well be paved with concrete if the highway is paved and carries heavy traffic. In such case the ties should all be renewed with treated timber and the track dug out four inches below the bottom of the ties. The track can then be blocked up at the correct level and concrete of high early strength tamped under the ties and filled in around the rails, necessary flangeways being provided. Such a crossing will require no further attention until it is necessary to rebuild it.

Rail-Type Crossings

Many highway crossings have been constructed of rails, of either fair, second-hand or good scrap quality. If the rails are carefully selected and are of equal height, and care is taken to provide a uniform bearing, a smooth-riding crossing can be constructed which will be economical, provided the track structure is unyielding. The space between the running rails should be filled with intermediate rails laid as closely as possible and still allow room for spiking. The distance between adjacent rail heads should not exceed four inches in any case and when necessary the rail bases can be notched to permit spiking. Creosoted hardwood shims of the proper height to bring the crossing rails level with the running rails should be spiked to each tie. These shims should be surfaced to exact thickness and should be at least seven inches in width. Creosoted sawed ties, 7 in. by 9 in., of sufficient length to permit the spiking of the outside approach rails, should be used throughout the crossing. The outside ends of the rails should be beveled at not more than 45 deg. with the horizontal, to prevent possible damage from dragging equipment.

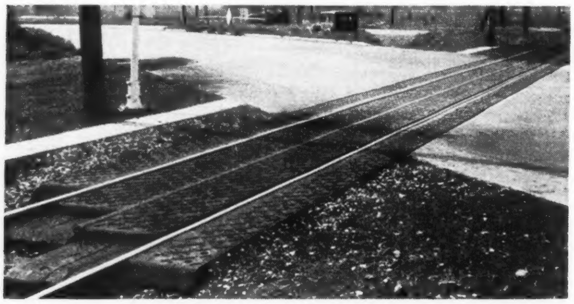
In signal territory the center rail should be replaced with a creosoted wood filler to provide insulation. After completing the installation of the crossing rails, the openings on both sides of the running rails, as well as all other spaces between crossing rails, should be filled to the top with poured bituminous filler. A crossing constructed as outlined above makes repairs to the track very expensive. When taking up such a crossing, it becomes necessary to build a detour to carry highway traffic, or to close the road during the course of work.

Metal Crossings

The search for the more permanent construction of grade crossings has resulted in the introduction of several types of metal crossings, all with the intent of providing units which can be easily taken up and replaced to permit the ready maintenance of the track structure and to provide smooth, non-skid and noiseless crossings. Examples are described below:

Ramapo Ajax—The Ramapo Ajax Corporation, New York, manufactures a crossing of this type that is constructed of semi-steel castings, provided with a non-skid checkered surface and the necessary ribs and flanges to provide the requisite beam strength, suitable bearings and wheel flangeways. All units have

a length of 24 in. lengthwise of the track, there being two lines of these inside the rails and one line outside of each rail. A system of wood filler blocks, shims and wedges provides the insulation and anchorage on the gage side of the running rails while a lip that engages the under side of the head, serves to hold the units in place on the outside of the running rail as well as along the center line of the track, where a rail of the same pattern as the running rails is spiked to the ties. Direct attachment to the ties by means of lag screws is required only along the outside edge of the outside units. The method of holding the units in place is such that they are readily removed for the conduct of work on the track, the weight of the units being such that they



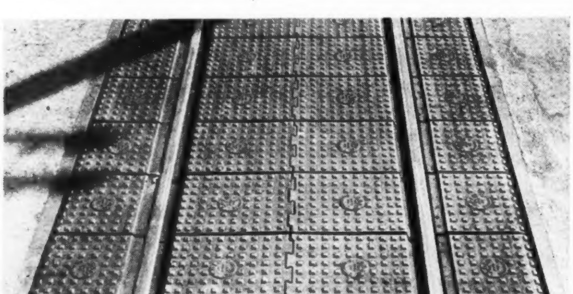
Example of a Metal Crossing

may be lifted by two men. The units are interchangeable from one location to another with any standard section of rail.

Truscon Crossing—The Truscon Steel Company, Youngstown, Ohio, manufactures two types of steel crossings. The all-steel crossing, Type-A, consists of heavy steel "planks" having an exclusive safety tread. The sections, of ¼-in. material, are 3 in. in depth, 5⁵⁄₁₆ in. in width, and have a standard length of 9 ft., although any lengths up to 18 ft. may be provided. The sections are laid parallel with the rail and are brought flush with the top of rail by means of wood shims which are spiked to the ties. The sections are secured in place with lag screws, the heads of which sink into specially formed recesses, leaving the road surface smooth. Insulation is secured by the use of creosoted oak or asphalt fillers between the running rails and the metal plank.

Type "B" consists of a pressed-steel form, 6 in. by 16¾ in. by 6 ft. long, having a checkerboard top. These steel forms are filled with concrete by the railroad and when complete weigh approximately 700 lb. No fastening is used with this type, it being claimed that these sections will stay in place by their own weight. Insulation is obtained by wood filler blocks on each side of the running rails.

Bull Frog Crossing—The Indianapolis Switch & Frog Co., has developed a crossing constructed of malleable units 20 in. in



Another Type of Metal Crossing

length, supported on the track rails, using rubber cushion insulators to afford some resilience, as well as to eliminate the noise of bearing of steel on steel. The support and fastenings require the use of three stringer rails, one in the center of track and one on each side of track near the edge of pavement. By special locking units, the crossing or any part of it may be easily removed to provide access to the track.

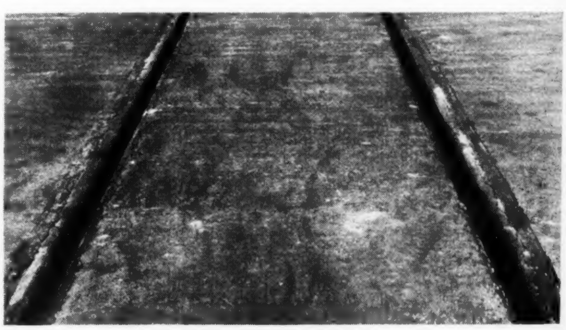
Titan Highway Crossing—This crossing, which is manufactured by the Weir-Kilby Corporation, Cincinnati, Ohio consists of a system of steel channels, angles and forged supports for a checkered T-plate, that forms the running surface of the crossing. This top plate is bolted to the supports, which rest directly on top of the track ties. The center support consists of two channels, back to back, with insulation between them.

Smithsteel Crossing—The A. O. Smith Corporation, Milwaukee, Wis., has introduced the "Smithsteel" crossing, consisting briefly of copper bearing steel locking bases that are spiked to the ties, copper bearing steel deck channels and special flangeway and end ramp sections that rest on the locking bases and are held in place by clips. The height of the locking bases is varied to suit the rail height. The section of crossing between the track rails is divided into three panels by creosoted wood insulating boards. It is claimed that this type of construction permits the easy removal of deck channels in order to make track repairs, it being necessary to drive these deck channels only a few inches longitudinally, in order to lift them out. The crossing provides a non-skid surface.

Diamond-Pattern Crossing—The Alan Wood Steel Company, Conshohocken, Pa., has adapted its diamond-pattern steel floor plate to the construction of a steel surface highway crossing. This crossing consists of a solid timber deck laid parallel with the track rails, at the proper height to allow a ¼-in. floor plate to be level with the track rails. The plate is fastened to the deck with ⅜-in. diameter drive screws 3 in. long. Insulation is provided at the center of the track by a one-inch insulation filler between the plates. Special filler blocks provide the flangeway.

Flangeway Guards

The protection of the flangeway is one of the important features of any well-constructed crossing. Such a flangeway guard should absorb as much of the running-rail vibration as possible, in order to protect the cross-



A Flangeway Installation

ing from damage. It should be as free from contact with the running rail as possible and still leave the least amount of opening for water and dirt to get into the track structure. If the trough of a closed type of flangeway is of soft material, it will tend to fill up with snow and ice in winter much more readily than one of steel construction, due to the action of wheel flanges through the flangeway.

A good flangeway guard can be made of a light rail section, such as the 60-lb. A.S.C.E. section, placed on its side with the head fitting against the web of the running rail and supported so as to provide a reasonably tight fit under the head of the running rail. Care should be taken in installation to see that the flange rail is securely supported and fastened to prevent it from tipping. The C.R.S. Continuous Web Crossing Flangeway, manufactured by The Cleveland Railway Supply Company, Cleveland, Ohio, is of the closed-trough type, and affords opportunity to spike it securely in place. The Bethlehem braced flangeway guard, manufactured by the Bethlehem Steel Company, is of the open-trough type. It is fastened independently of the running rail and, therefore, will not transmit rail movement or vibration to the crossing material.

Crossings can be installed and maintained by section forces at less expense than by bridge and building forces, and if properly trained, the former will do a creditable job. If crossings are constructed by the gangs on their own sections, their pride in a good job will encourage better maintenance of the crossings. In general, the service life of any of the accepted types of grade crossings will reflect very definitely the degree of care exercised in design and installation. Adequate and uniform bearing on the track structure must be provided if the crossing is to carry the heavy highway traffic of today. If the pavement level does not coincide with the top of rail, the crossing will not only ride rough but this will result also in undue abuse of the crossing material. Co-operation with the state highway departments or city street officers will correct many of the poor riding conditions of otherwise well constructed crossings. The railroads can ill afford to convey the "public be damned" attitude to the traveling public on the highways, by providing unsafe and rough grade crossings.

Committee: J. J. Davis (Chairman), supervisor, E. J. & E., Joliet, Ill.; G. G. Austin, supervisor of track, C. J., Chicago; F. J. Meyer, assistant engineer, N. Y. O. & W., Middletown, N. Y.; W. Rambo, roadmaster, M. P., Poplar Bluff, Mo.; E. Rost, supervisor, B. & O. C. T., Chicago; L. M. Denney, supervisor of track, C. C. C. & St. L., Indianapolis, Ind.; F. B. Lafleur, roadmaster, S. P., LaFayette, La.; M. J. Connerton, supervisor, I. C., Chicago; J. M. Reardon, supervisor, N. Y. N. H. & H., Hartford, Conn.

Discussion

J. J. Desmond (I.C.) inquired whether there is any advantage in mixing bituminous materials for crossing construction on the job or whether it is better to apply premixed materials and whether moisture in the aggregate is of disadvantage when the material is mixed on the work. Mr. Davis replied that this depends entirely on the character of the materials used, some manufacturers specifying dry aggregates while others recommend the addition of a small amount of water during the mixing process. E. P. Safford (N.Y.C.) said that his experience in removing bituminous crossings to permit repairs or the lining and surfacing of the track indicates that the cost of doing so is entirely too high and that for this reason, as crossings of this type come up for renewal, he is replacing them with treated plank. He emphasized the desirability of using previously-framed shims to give a proper surface to plank crossings, saying that such surface can seldom be obtained where the shims are framed on the ground. He also recommended the use of variable length planking instead of the commonly-used 16-ft. length as the former can be purchased considerably cheaper and gives as good results as the 16-ft. lengths.

A. H. Peterson (C.M.St.P. & P.) stated that on his territory he has in service every type of crossing mentioned in the report. His experience has been that emulsified asphalt crossings give the most satisfactory service from every point of view but that the rail joints must be eliminated or the crossing will be badly damaged, if not destroyed. J. B. Kelly (M.St.P. & S.S.M.) called attention to the difficulty of preventing boat spikes from protruding in plank crossings and damaging pneumatic tires on automobiles, and recommended that boat spikes be countersunk. It has been his experience that bituminous crossings give better results where ¾ in. granite chips or other sharply broken stone is mixed with the gravel as an aggregate. He has had considerable damage done to monolithic concrete crossings by false flanges crushing the concrete immediate outside the rail. This has now been corrected by keeping the concrete about ¼ in. below the running surface of the rail. Mr. Kelly inquired whether it is necessary to use tie plates and standard tie spacing in connection with monolithic crossings. T. F. Donahoe (B. & O.) recommended a closer tie spacing and the highest quality of ties that can be obtained, together with heavy tie plates for this type of construction.

W. E. Carter (B. & L.E.) described a creosoted gum plank crossing which he had just installed, in which the tie spacing was reduced to 18 in. in order to give better support to both the crossing plank and the rail. R. J. Yost (A.T. & S.F.) stated that he is using treated plank crossings of two designs, (1) with the flangeway framed into the plank adjacent to the rail, and (2), with independent flangeways. His preference is for the latter since no difficulty is experienced with the lifting of the plank adjacent to the rail. He inquired whether the committee recommended filling the ballast to the top of the tie or to the under side of the planks. Mr. Davis replied that the practice on his road is to keep the ballast about 3 in. below the top of the tie where plank crossings are used in order to provide space for debris to sift through the planking.

W. J. Daehn (C. & N.W.) cautioned against the use of too rich a mixture of bitumen since this may reduce the life of the crossing. Furthermore, it makes the mix ture so soft that a smooth surface cannot be maintained. B. E. Haley (A.C.L.) said he had found the all-rail type of crossing most satisfactory. In constructing these crossings, he welds three plates across the bases of the rail to hold them rigidly together. He has found that this facilitates the installation and repair of crossings of this type since they can be rolled into place originally and rolled out again for the purpose of repairing the track. Where plank crossings are to be installed, he prefers to use 6-in. by 12-in. crossing plank instead of the usual 4-in. thickness, as this construction lasts longer and is more satisfactory. He stated that all types of crossings except plank should have a flangeway on the outside of the rail corresponding to the inside flangeway to permit movement of the rail without damage to the crossing materials.

J. B. Martin (N.Y.C.) said that a poor crossing is the poorest sort of publicity for a railroad. He is now replacing other types of crossings with treated plank construction as they are easy to repair and economical in both construction and maintenance. He has found that they are well received by the public but in order to make them satisfactory much care must be used in their installation. A poorly installed crossing will always give trouble. J. J. Clutz (Penna.) inquired about the best method of maintaining highway grade crossings where trolley tracks also cross the steam railway tracks. J. P. Corcoran (Alton) replied that no type of crossing except plank can be maintained satisfactorily under the condition specified.

P. J. McAndrews (C. & N.W.) emphasized that additional ties should be placed through highway grade crossings and proper drainage provided. He said that the present practice on his territory is to install monolithic crossings on sidings wherever streets are being paved. T. F. Donahoe (B. & O.) called attention to the three-rail type of crossing which is being used on a number of roads. In this type of construction the space between the rails is filled with a bituminous compound, special provision being made for drainage. Several others reported have used this type of crossing and found it very satisfactory. R. L. Simms (C.B. & Q.) stated that his experience with asphalt crossings had been most satisfactory and that this type of crossing is being used wherever practicable. The chief difficulty he has found

with plank crossings is that they do not protect the track from rain and that, therefore, roadbed conditions are seldom at their best under crossings of this type.

F. B. Lafleur (S.P.) stated that the state highway department of Louisiana has designed a crossing which it has made standard for use on all state highways. The state furnishes all the material including special ties, for the crossing. When necessary to repair or renew the crossing, the highway department upon notification, provides police and flag protection, closing the road if necessary during the progress of the repairs and bears the expense of any material and labor that may be required. In making the original installation, the entire track structure is renewed, from the roadbed up. Drain pipes are installed on both sides of the track and an expansion gap is left between the crossing and the paving.

Methods of Cleaning Stone Ballast

Report of Committee

L. J. Drumeller
(Chairman)

PROBABLY one of the most important problems that has confronted maintenance officers during the last five years has been that of keeping the ballast section cleaned, particularly in stone-ballasted territories. This condition was largely brought about by a curtailed labor allowance which made it necessary to divert practically all available funds to line and surface, tie renewals, and such other maintenance work as was necessary for the safe operation of trains. These conditions resulted in the usual ballast cleaning and renewal cycle being prolonged two and, in some cases, three fold.

Clean, crushed stone ballast is recognized as the most satisfactory ballast in dense-traffic territory, and one of the underlying requirements of a well maintained railroad is clean, live ballast. Those railroads which were able to maintain such a condition through the past few years are fortunate.

Before discussing the various methods of cleaning stone ballast, it may be well to outline briefly some of the major conditions that cause ballast to become foul. They include the following:

1. Inadequate surface and subsurface drainage.
2. Battered rail ends, causing joints to vibrate excessively under wheel loads.
3. Burned rail, due to slipping drivers, bringing about the same condition as in Item 2.
4. Front-end sparks from locomotives operating on heavy grades.
5. Commodities such as coal, coke, etc., in territories close to the points of loading.
6. Leakage through floors and hopper-bottoms of cars.
7. The elements, causing the deposit of wind-blown dirt, etc., on ballast.
8. The kind and size of the ballast.
9. Sanding rails on heavy grades and at starting points, such as stations, signal locations and water stations.
10. Continuous switching on main lines where no switching leads are provided.
11. Fine stone screenings or shale from crumbled limestone, which is likely to be loaded at the quarries with the crushed stone if not properly inspected.
12. Narrow side ditches where cuts are too narrow to permit proper ditches, thereby retarding drainage.

Stone ballast is used chiefly on the eastern railroads and from these railroads it is learned that the interval between ballasts cleanings varies from two to eight years, depending chiefly upon traffic conditions and the location. As pointed out by a maintenance officer of one of the country's leading railroads, the cleaning of stone ballast improves the drainage by removing the dirt and opening up the voids between the stones. When such a condition of the ballast is maintained continuously it results in the following:

1. Drains surface water away from the track.
2. Reduces the labor of maintaining line and surface.
3. Increases the life of rail, ties, fastenings, etc.
4. Improves the general appearance of the right-of-way and, to a large extent, keeps down the dust.

In the past 12 years various machines have been developed for the cleaning of stone ballast, but prior to that time practically all ballast was cleaned by hand.

Methods of Cleaning Ballast by Hand

Hand cleaning of ballast is done with both forks and screens. In cleaning ballast with forks, the ballast is dug out with picks and shovels and thrown upon the roadbed shoulder. If wet or damp, it is first allowed to dry and is then shaken clean with the aid of forks and cast back into the track. Another method of cleaning ballast in the cribs with forks is to dig out one crib completely and fork clean ballast back into it from the adjacent crib, this performance being repeated throughout the section of the track being cleaned. In applying this method, the margin ballast is usually forked up in between the rails and behind the crib-cleaning, allowing the waste to fall upon the roadbed shoulder. The roadbed is then cut down to proper depth below the ties to provide adequate drainage and the ballast is replaced. When cleaning the intertrack space with forks, a common method is to dig a hole to the proper depth below the ties, and then fork the clean ballast progressively to the rear, removing the dirt which falls through the ballast forks with a shovel at suitable intervals by casting it over the side of the embankment.

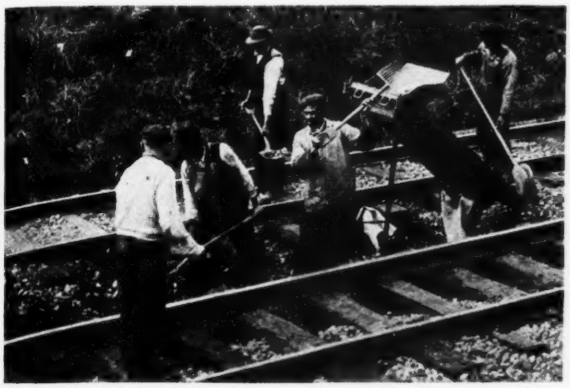
Portable Screens Were Introduced

With the increasing need for maintaining clean stone ballast, certain ballast screens were introduced. Possibly the one most commonly used is about three feet wide and six feet long, which is placed in position for use with one end resting on the ground and the other on standards that are adjusted to provide any desired slope. The best results are usually obtained by placing the screen on a 45-deg. angle. Ballast is shoveled upon the screen near the top and allowed to roll down, the waste passing through the screen into a metal tray beneath and the clean ballast rolling back on the ground. When full, the metal trays are removed and the waste is thrown over the side of the embankment or along the roadbed shoulder.

With both the hand and screen methods of cleaning ballast, it is advisable to assign each man a designated

portion of track over which to work, say one rail length, thus not only spacing the force to provide closer supervision but also setting up competition among members of the gang.

Under the very best conditions, the cleaning of stone ballast with either forks or screens is expensive, and in some cases it is considered more economical to throw away the old ballast to a certain depth below the ties and add fresh ballast than attempt to clean the old ballast. This depends, of course, on how old and dirty the ballast is and over what distance it is necessary to haul the new ballast. The cost of cleaning stone ballast by hand, with either forks or screens, varies widely, depending on the condition of the ballast, traffic density and wages.



The First Step Toward More Effective Ballast Cleaning

In view of the recognized importance of keeping stone ballast clean and the almost prohibitive cost of performing this work by hand, machines of various types have been developed and placed in service on various railroads throughout the country. These are discussed below.

The MacWilliams Mole Ballast Cleaner

Ballast moles have been in operation since the summer of 1926, when eight of them were built and delivered to two railroads. Since that time, 203 moles have been put in service on 14 different railroads.

These machines are powered by gasoline engines and are designed to work both in the margin ballast and in the intertrack space. They will clean to depths ranging from 14 in. to 24 in. below the tops of the ties, depending on the requirements of the railroad on which they are employed. Moles working in the intertrack space are provided with two lines of portable racks in about 10-ft. sections, one line being laid on the inner tie ends of each track. This rack serves to keep the machine in a true line. As the mole progresses, the racks are taken up from the rear and placed ahead. The shoulder or margin moles are likewise equipped except that they have only one line of portable rack, placed on the outside tie ends, and are supported on the opposite side by a large wheel which operates along the roadbed shoulder. The margin moles can also be worked in the intertrack space by removing the large wheel.

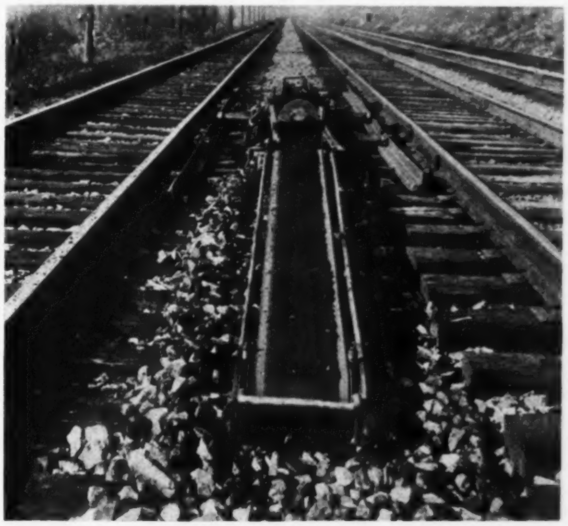
When these machines are operating, two digging arms located on the front end feed the ballast to a conveyor belt which carries it back and drops it on a shaker screen or agitator. The dirt drops through the screens on to a side conveyor belt which deposits it along the roadbed shoulder, whence it is later thrown over the side of the fill or hauled out of the cut, depending upon local conditions. The clean ballast, after passing over the screen, falls back into the space from which it was dug. When normally set, moles clear passing trains, but their operation must of necessity be discontinued while trains are passing.

These machines are usually operated in batteries of two—one in the intertrack space and the other in the margin, but it is reported that in four-track territory they are sometimes worked in batteries of three, one machine being operated in the intertrack space. The advantage of working more than one machine with a gang lies in the reduction in overhead expense, necessitating the use of only one foreman and a cook. It is also reported that in some instances the machines have been worked two eight-hour shifts per day.

Figures available during the last five years indicate that moles average from 700 to 1195 ft. per eight-hour day in the intertrack space and from 850 to 1200 ft. in the margin, the performance depending on the depth cleaned, on whether or not the crib ballast is dug out and thrown into the center and on the margin ahead of the mole, in which case it is necessary to work it in low gear, resulting in slower speed but maintaining about the same volume of ballast cleaned.

When being moved over highway crossings or other obstructions, the moles are lifted out of the intertrack space to a sufficient height to clear the obstructions by means of chain hoists supported from A-frames, which are propelled along the running rails of both tracks far enough to clear the obstruction.

Figures available on various railroads show that moles will clean the intertrack space at a cost of from 4 cents to 6 cents per lineal foot of track and about 3 cents per lineal foot along the margin, this cost being based on the cleaning of 20 miles or more per season and includes labor, fuel and supplies, running repairs, depreciation at 12½ per cent and annual general repairs.



The Ballast-Cleaning Mole

In double-track territories, mole No. 1 works in the intertrack space and mole No. 2 along the margin. In three-track territories, the two moles usually work in both intertrack spaces and in four-track territories three moles are used, one in the track centers. In the latter case, the outside moles are equipped with side conveyors for waste disposal and span one track, while the middle mole is not equipped with a conveyor but deposits its waste in pans or baskets which are carried across the tracks and dumped over the shoulder by hand.

The average organization of a gang operating two moles is as follows:

Intertrack mole.
1—Operator, who also acts as foreman
3—Men moving racks, adzing ties, flag protection, etc.
1—Man handling conveyor and leveling dirt
1—Cook

Total 6—Men

Margin mole.
1—Operator, who also acts as assistant foreman
2—Men moving racks, adzing ties and leveling dirt

Total 3—Men

The number of men varies, depending upon conditions and whether the cribs are being cleaned in whole or in part and also whether operating in cuts or in multiple track territory, where it is impossible to dispose of dirt in the usual manner. It is also usual in mountainous territory where the alinement is crooked to provide one man, stationed at a point of vantage, to look out for approaching trains. This man, however, can be used for leveling down the waste along the roadbed shoulder.

In four-track territory where three moles are operating, one of them in the track centers, the usual setup of the organization is as follows:

Mole No. 1
1—Operator
2—Laborers changing racks
1—Laborer cutting down waste

Total 4—Men

Mole No. 2
1—Operator
2—Laborers handling racks
6—Laborers handling waste pans

Total 9—Men

Mole No. 3
1—Operator
2—Laborers changing racks
1—Laborer cutting down waste along roadbed shoulder

Total 4—Men

This organization is, of course, in charge of one foreman and also has a water boy. Mole No. 2 works in the middle intertrack space.

Brownhoist Ballast Cleaner

The Industrial Brownhoist Corporation has developed a machine for cleaning ballast that consists principally of two main units, one for excavating and hoisting the dirty ballast and the other for screening the ballast. Each unit is mounted on a steel frame car and when the cars are coupled together they form one unit.

Two clam-shell buckets are used to excavate the ballast, spaced on about 15-ft. centers, and capable of excavating to a maximum depth of about 30 in. below the tops of the ties. These buckets are operated in curved channel guides which direct them over the center of the car in an upward movement and which prevent them from swinging beyond the mid-point of the intertrack space when in the lowered position. A plow is located between the buckets, which can be raised and lowered on guides, and is designed to push the ballast from the far half of the intertrack space to a point within the reach of the rear bucket.

Directly beneath the buckets in their raised position on the center of the car are receiving hoppers, underneath which an apron conveyor transports the dirty ballast to the rear of the car. From that point the ballast is dumped into a hopper which feeds an apron conveyor on the screening car unit which, in turn, carries the ballast to vibrating screens for cleaning. The dirt passes from the screens into a chute whence it is carried by another conveyor to the rear end of the second car, while the clean ballast is dumped into a hopper beneath the screens preparatory to redistribution in the track. The dirt is disposed of along the shoulder, over embankments or in cars coupled behind the equipment. This is made possible with a boom loader which can be swung through 180 deg. at the rear of the screening car. If the dirt is to be disposed of in cars, it is conveyed by the loader to a receiving hopper over a belt conveyor line which extends over the dirt cars.

This machine is moved as a unit to the point of operation by a locomotive, which is then spotted some distance from the machine, and the equipment pulls itself forward by means of an electric haulage unit fastened to the engine and the machine. The power for the operation of all of the equipment on the ballast cleaner is supplied by a gasoline-engine generator set.

On one road these Brownhoist machines have been employed in extensive ballast cleaning operations, and it is reported that they cleaned approximately 7,100 lin. ft. of intertrack space per 8-hour day, to a depth varying from 22 in. to 24 in. below the tops of the ties. No unit cost of cleaning ballast with this machine has been reported to this committee.

The Brownhoist Machine

Speno Ballast Cleaner

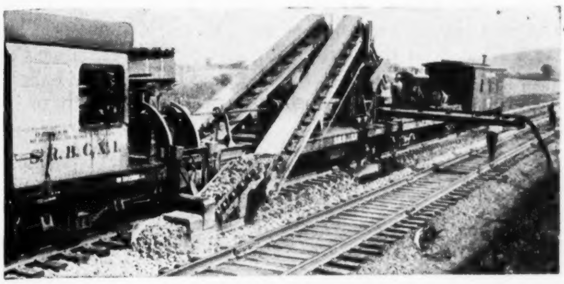
The Speno ballast cleaning machine was developed and introduced in 1929. It is a flat-car mounted unit, consisting of a twin arrangement of scoops, belts, belt conveyors, vibrating screens, ballast chutes and scrapers—one on each side of the car, and it is also equipped with a swing conveyor for the disposition of dirt.

The screens operate independent of one another and are so arranged that both the intertrack space and the margin can be cleaned simultaneously, if so desired. The scoop, when in cleaning position, picks up a volume of ballast 29 in. wide and of uniform depth below the top of tie, depositing it on an elevating belt conveyor fixed rigidly with the scoop which, in turn, conveys the ballast to a longer elevating belt conveyor. The conveyors are so arranged that the dirty ballast is carried to the top of an inclined vibrating screen and after passing over this screen the clean ballast falls into a hopper with discharge chutes, from which it can be delivered either to the intertrack space or between the rails into the cribs. The waste from the cleaned ballast falls into an open-top hopper car and then on to the dirt belt conveyor, arranged at its inner end so that it can be swung to either side of the car for discharge over the roadway shoulder

or directed to the rear for discharge into refuse cars.

The minimum track centers on which this machine can be continually operated while trains are passing on an adjacent track is 12 ft. 8 in. The scoops can be quickly pulled up flush with the sides of the car when it is desired to clear traffic or to move the machine over the road.

Two large eastern railroads have worked two of the Speno machines under contract over a large mileage of road. This equipment was handled over the track by either a steam or a gas-electric locomotive. It is reported that on both railroads the cleaning was done to a depth of 15 to 18 in. below the tops of the ties. When in the cleaning position, the equipment is moved over the track at an average speed of about one mile per hour.



A Speno Cleaner at Work

This machine makes three passes over the intertrack space and two passes over the margin ballast. One road reports that in an 8-hour day it completely cleans two miles of road, consisting of one intertrack space on either side or an intertrack space on one side and the margin on the other. No definite cost of cleaning ballast with the Speno machine was reported to this committee.

Fairmont Ballast Cleaner

The Fairmont ballast cleaner was first used in 1931. Somewhat altered and refined in design, this machine was operated on a contract basis to a considerable extent in 1933. It consists of a 65-ft., 105-ton all-steel, gas-electric car, behind which are coupled two standard 50-ft. flat cars equipped with dirt disposal machinery, with a fourth unit consisting of an office and supply car that carries spare parts and equipment for making emergency repairs on the job.

Ballast is plowed up on each side of the track and screened by two 15-ton cleaner boxes, these boxes being hung in wells midway on each side of the machine. By means of hydraulic cylinders, these boxes can be swung out and down when in operating position and are quickly raised and swung back flush with the sides of the car to clear passing trains.

Each cleaner box has two vertical in-gathering wings mounted on the front end flush with the bottom of the box. Each wing is separately controlled by an hydraulic cylinder. The opening between the wings can be varied so that all ballast between ties of adjacent tracks can be gathered in, where they are not less than 38 in. nor more than 64 in. apart. Either wing can be moved in or out to maintain correct distance from short or long ties without stopping the car.

These machines will clean normally from a depth of 18 in. below the top of tie to a maximum depth of 24 in., depending upon requirements. A work train is used in connection with this machine, the locomotive taking a position with its brakes set about 500 ft. ahead of the cleaner and the cleaner then propels itself forward by winding up a steel cable attached to the locomotive. As the car moves forward, the wings dig into the ballast to the required depth and about one inch is undercut below the ties. The ballast is forced into the boxes and is conveyed over a series of screens. The ballast is then agitated, separating the dirt from the ballast, the clean ballast being conveyed back to the rear of the box where it is distributed into the track and shaped up to the proper contour, in the center or on the margin. By means of a suitable conveyor, the dirt from the ballast can either be wasted along the roadbed shoulder or deposited into the two-car dirt unit attached to the train.

The dirt cars have 8-ft. steel-lined side walls and together can store about 150 cu. yd. of dirt, enough for 1500 to 4000 ft. of track, if the cleaning is done on both sides. Dirt is stored only when working in cuts or at points where it cannot be wasted adjacent to the place of cleaning. When there is no suitable dumping place, a two-way drag-line scraper hauls the dirt into the cars and when full the cleaner moves ahead to the nearest spot where dumping is permitted and resumes ballast cleaning while the dirt cars are being unloaded, thus avoiding idling time while dumping the dirt cars.

During an 18-day period in 1933, this machine cleaned 248,872 ft. of track, composed, in part, of intertrack space on both sides, and at other points of intertrack space on one side and the margin on the other. This was accomplished by working two 8-hour shifts and resulted in production equivalent to 6,913 lin. ft. of track cleaned per 8-hour shift. Based on 1933 figures, the cost of cleaning with this machine was 4.17 cents per foot of intertrack space, and for the margin it was 2.12 cents.

The Fairmont Machine

Other Machines

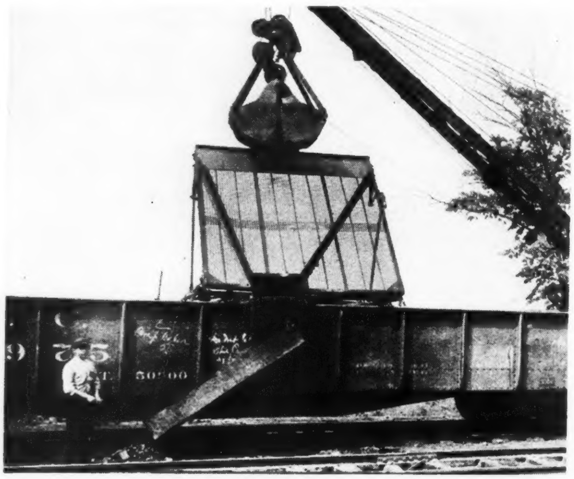
Locomotive and ditcher cranes are also used to clean stone ballast, but with the advent of machines designed specifically for ballast cleaning these cranes and ditching outfits have been diverted to other work. These cranes were equipped with clam-shell buckets and worked under their own power between two gondola cars. Screens, both stationary and vibrating, were mounted on the tops of these cars. The clean ballast, after passing over the screens, drops back into the track and the dirt drops into the open-top cars which, when full, are hauled to side tracks or other convenient points for discharging the dirt.

Two other machines that are not used for actual ballast cleaning merit notice in this report, because they are used on one of the large eastern railroads to remove

dirt, cinders, etc., from the tops of the ties and ballast. One machine is a sucker and the other a sweeper.

The function of the sucker is to draw dirt, refuse, etc., from on top of the ballast and deposit it in cars attached to the equipment. This is accomplished by means of a series of pipes which span the width of the track, the necessary vacuum being produced by a steam siphon with steam from the locomotive used to propel this equipment over the track.

The sweeper consists principally of a rotary steel broom and is power-operated. When in operation, the broom sweeps dirt, cinders, etc., from the top of the ties and ballast on to a pan attached just ahead of it and,



Locomotive Cranes and Clamshell Buckets Have Been Used

by a series of conveyors, the refuse is finally deposited in an open-top car coupled to this outfit. Neither of these machines is designed, in the common understanding of the terms, as a ballast cleaner but they act more as a preventative than a cure for foul ballast.

Should the Crib Ballast Be Cleaned?

All of the machinery for cleaning ballast mentioned in this report confines such cleaning to the intertrack space and the margin ballast. The opinion of most maintenance officers of the eastern railroads varies as to the advisability and necessity of cleaning ballast in the cribs. Some maintenance of way men are of the opinion that when the margin and intertrack space are cleaned and after the track is raised, the crib ballast acts as a water shed and drains the water from the center of the track both ways to the intertrack space and the margin.

It is the opinion of this committee that the ballast in the cribs is just as important for the proper drainage of track as the ballast in the center and on the margin and that it should, therefore, be cleaned. This opinion is based on the assumption that where track is raised, the old ballast in most cases is tamped under the ties and new ballast is supplied with which to dress the track, and it is considered very important to get good, clean ballast under the ties.

A new machine, of which as yet little is known, is equipped with a series of teeth, by means of which the ballast is dragged from the cribs to each side of the track. This machine is mounted on a small car and is self-propelled and operated by a gas engine. The function of this machine is primarily that of preparatory work and it is not, in the usual sense of the word, a ballast-cleaning machine.

There is also on the market a scarifying, or discing, machine. This unit is designed principally to afford better drainage to the ballast and its function is to work along the track under its own power discing or plowing out the ballast along the margin.

Another question on which there is also a wide variance of opinion, concerns the cleaning of the intertrack space to various depths. Some maintenance officers contend that the cleaning of ballast in the intertrack space simply provides a hole in which water will stand. This is possibly true at some restricted locations, and such locations should be provided with special drainage under the track. It is the opinion of this committee, however, that, generally speaking, the subgrade beneath the ballast is porous enough to absorb such water that gathers in the intertrack space.

This committee presents below a comparison of the amount of stone ballast cleaned by various railroads from 1928 to 1933, inclusive, this information being taken from material published in the March, 1934, issue of *Railway Engineering and Maintenance,* page 144, and for which this committee has the supporting data:

	Aver. 1928-1930 inc. (track miles)		1931		1932		1922	
Road	Shoulder Ballast	Intertrack Ballast	Shoulder	Inter-Track	Shoulder	Inter-track	Shoulder	Inter-track
A	5	50.0	40.0	194.0	....	35.0	18.0	167.0
B	....	....	....	97.0	1.0	40.0	28.0	80.0
C	20.8	79.6	81.0	134.0	117.3	191.0	149.6	150.3
	(1930 only)							
D	110.0	114.0	36.0	37.0	....	....	....	....
E	76.0	295.0	36.0	140.0	20.0	77.0	24.0	96.0
F	228.2	253.0	337.4	260.0	216.0	166.4	230.2	254.4
G	....	180.3	....	79.0	....	47.0	....	99.0
H	(Data not available)		206.8	714.7	275.7	1,193.5	356.7	1,146.6

In conclusion, attention is called to the fact that every precaution must be taken during the hot summer months to prevent track from buckling while ballast cleaning is in progress; this is true especially when cleaning ballast in the cribs. To guard against the possible buckling of track, the crib ballast, when dug out and cleaned, should be thrown back into the crib immediately. If this is not practical, particular attention should be given to proper adjustment of rail anchors to prevent creeping and provision made for the necessary expansion of the rails at the joints or the location where the ballast is being cleaned must be protected by a slow order.

Committee: L. J. Drumeller, (Chairman), division engineer, C. & O., Hinton, W. Va.; W. A. Clarks, supervisor of track, Reading, West Trenton, N. J.; G. T. Donahue, supervisor of track, N. Y. C., Richland, N. Y.; O. Surprenant, roadmaster, D. & H., Schenectady, N. Y.; J. A. Snyder, roadmaster, M. C., Detroit, Mich.; W. R. House, supervisor of road, B. & O., Martinsburg, W. Va.; R. R. Nace, engineer maintenance of way, Long, Island, New York; A. Smith, roadmaster, D. L. & W., Stroudsburg, Pa.; P. L. Koehler, assistant division engineer, C. & O., Huntington, W. Va.

Discussion

J. J. Clutz (Penna.) stated that he had found it necessary to provide cross drains from between tracks to the outside at breaks in grade and at highway crossings. J. J. Desmond (I.C.) inquired whether the machines described in the report require any hand work for the purpose of getting at the ballast at the ends of the ties. Mr. Drumeller replied that this is not necessary since the machines either undercut the ties or have blades which remove the ballast at the ends of the ties.

A. M. Clough (N.Y.C.) suggested that effort should be made to require a quarry furnishing stone ballast to comply with the specifications and remove all material smaller than the lowest size specified; otherwise, this fine material must eventually be removed through a cleaning operation and, in the meantime, the railroad is carrying an investment for material which is detrimental rather than beneficial to track conditions and must sooner

or later be discarded. J. P. Corcoran (Alton) called attention to the difficulty sometimes experienced in controlling the sizes of ballast obtained from a quarry which is also furnishing stone for highway work. Earl Crowley (D. & H.) suggested that the committee might well have made recommendations for a method of inspection to insure that doors on hopper cars be kept tight to prevent coal dust and other dirt from filtering into the ballast. He recommended as a partial means for delaying the cleaning of stone ballast, that where a raise of, say 10 in. is made in applying ballast, the first 7 in. of new ballast should consist of 3-in. stone and that the final lift should be made on ¾-in. stone.

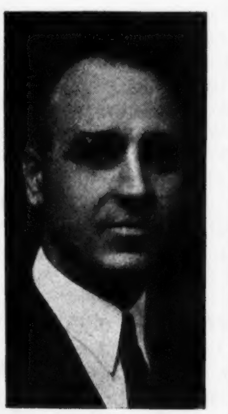
C. W. Baldridge (A.T. & S.F.) said that the problem of developing machines for cleaning ballast remains as the most important one in maintenance yet to be solved. He agreed with G. T. Donahue (N.Y.C.) that the cribs should be cleaned at the same time as the shoulders. Mr. Desmond inquired why a number of the eastern roads do not fill the cribs to the full height of the ties but in some cases leave the ballast from two to three inches below the tops of the ties. In reply, Mr. Donahue said that this is done to keep the ballast away from the rail and thus avoid interference with the track circuits, particularly where the ballast has become foul. In general, ballast in this condition is given a slight crown for drainage. During this part of the discussion, Mr. Baldridge supported Mr. Crowley's suggestion with respect to using coarse stone for the first lift and finer stone for the final lift, maintaining that this would have been very beneficial during the past dry season in many sections of the West where sand and dirt had drifted badly over the track and fouled the ballast.

T. F. Donahoe (B. & O.) described another type of screening equipment which was not mentioned in the report. This consists of an ordinary flat-bottom gondola car with a screen 22 ft. high which is so designed that as it segregates the dirt and usable ballast, the dirt is delivered on the shoulder of the roadbed while the cleaned stone can be delivered either into the cribs or the intertrack space or on the shoulder. The foul ballast is removed from the track by means of a clamshell bucket, but where the ballast is muddy, it is desirable to use a plow in advance of the clamshell operation. With this equipment, the buckling of track is avoided automatically, provided not too much of the track is cribbed ahead of the cleaning operation. Where the ballast is very dirty, it is necessary to send two men ahead with picks to break the crusted ballast away from the ends of the ties in order that it may be picked up by the bucket.

The New Goal in Safety

By J. E. LONG

Superintendent of Safety, Delaware & Hudson, and President, National Safety Council, Albany, N. Y.



J. E. Long

THE safety movement in America is not new. It originated more than 20 years ago, coincident with the birth of the National Safety Council, and we as railroad men can feel justifiably proud of the fact that the railroads (represented by the Chicago & North Western) were among the handful of leaders who helped to organize the council and to formulate the principles of safety on which all accident prevention effort is based. Today practically every railroad in the country has an efficient organization for the prevention of accidents, and safety has become more than a mere slogan in the minds of railroad employees. It has become, in fact, an integral part of our day-to-day activities as proven by the records of the Interstate Commerce Commission and of the National Safety Council, which indicate that since 1923 the accidental death rate for the United States as a whole has decreased only 7 per cent, while during the same period, the rate of accidental deaths among employees of Class I railroads has decreased 74 per cent. In other words, if all persons living in the United States had succeeded in reducing the national rate of accidents as rapidly as we have on the railroads, thousands of our citizens who are either crippled or are in premature graves because of preventable accidents, would still be alive and whole.

What is true of our railroads as a whole is likewise true of our maintenance of way and structures departments. Although the casualty rate for all railroad employees was reduced 21 per cent from 1930 to 1932, a 25 per cent reduction was achieved by your department in the same period of time. You are to be congratulated most sincerely upon this accomplishment, and, as the official representative of the National Safety Council, I bring to you the greetings and appreciation not only of the national officers and executive committee, but also of the membership as a whole.

At the same time, however, we must remind ourselves that our job is not and perhaps never will be completed. There is so much that remains to be done. There is no irreducible minimum until we have achieved the record of absolutely no accidents. Let that, then, be our goal, and let us consider together what procedure we must follow in order to attain that goal.

Methods Used in the Past

First, however, allow me to glance back down the safety road along which we have come to see if there is anything in the past which might help us to understand factors that now seem strange in these difficult modern days. In the perspective of the past 20 years there are certain safety landmarks that stand out clearly. They were not always as clear as they are today, and some of us from time to time have wandered from the straight path, but the safety movement has progressed just as the majority of us have held strictly to these landmarks, which may be more adequately termed fundamentals of accident prevention.

There are three of these fundamentals which are often grouped together as of major importance in our fight on accidents, namely, mechanical safeguarding, employee education, and engineering revision. Perhaps I should say that *today* they are grouped together for there was a

day when each of them was hailed as the newly discovered panacea for all our accident troubles. I can remember some of the dismay that early safety engineers experienced when it was found that safeguarding machinery did not stop all accidents.

In the reaction from this disappointment, perhaps it was natural for blame to fall with heavy force upon the so-called "careless" employee. Suddenly we conceived the idea that if we could educate him in safe methods, make him "think" safety all the time, he would automatically avoid danger like a machine. We compiled statistics proving that most accidents occurred through some failure of the thoughtless, inefficient, reckless worker, and we set out by safety committees, safety meetings and safety talks to teach him to avoid all accident hazards. Some of us even went so far as to consider of small consequence the 15 or 20 per cent of accidents that could be prevented by mechanical safeguarding, and we thus discontinued the practice.

Engineering Revision

But accidents continued, and one day at the Annual Safety Congress in 1919, Dr. Lucien W. Chaney ridiculed our over-emphasis on the evangelistic type of propaganda and expounded the principle of engineering revision. In an investigation of the iron and steel industry he had found that, while only 7 per cent of the cases studied were amenable to engineering revision, 57 per cent of the *deaths* and *major* injuries could probably have been prevented by engineering measures. Dr. Chaney, of course, did not advocate the abandonment of either mechanical safeguarding or sane and persistent employee education, but he added the necessary third element to make a balanced safety program.

Still we were not through with our development of safety fundamentals. Gradually we came to see that it was never fair to charge the employee wholly with the responsibility for accidents, even for those where guards had been wantonly removed or safe practices were violated. For a long time we had used the foreman as our key man in teaching safety to the employees, and now we came to realize that his supervision was also a fundamental factor in accident prevention. We pounded this conception home to him in meetings and countless other ways, and most of us gladly placed the full responsibility for accidents on his shoulders.

But there is a basic fairness in men's minds which manifests itself in higher character. If it was unfair to charge the worker with full responsibility for accidents because he must look to a higher authority for knowledge and direction, was it not equally unfair to place this responsibility solely on the foreman? Unless management not only gave authority, but also assumed full responsibility for the accident prevention program and its results, the safety campaign never could attain complete success. And looking back today over even a short period of years, we can see how the acceptance of this principle has revitalized the movement and how the dynamic force of executive direction has added new power to every safety fundamental.

There are, of course, other important principles of accident prevention work. But I have pointed out enough of these old landmarks to indicate the well traveled road we have come and to emphasize some of the difficulties, errors, disappointments and troubles we have endured. Let me emphasize again that it is only because leaders like yourselves have held strictly and enthusiastically to these old fundamentals that the safety movement has been so successful.

But what of our work for tomorrow? There are so many channels into which our activities could be directed that I sometimes wonder if we would not be more outstandingly successful if we were to concentrate our attack on those phases of the accident problem in which immediate action is urgent and from which the most lasting good will result. It may be that such a concentration of effort would defeat our own objective, but there is one activity in particular which I feel needs special emphasis and to which every railroad supervisor can well afford to devote a good share of his time and thought. This activity has to do with the investigation of accidents.

During the past 10 or 15 years, I have talked to hundreds of supervisors and from this experience I am led to believe that the complete investigation of accidents involves merely the answering of six simple questions. The first four of these questions are:

1. Was the machinery or equipment faulty in any way?
2. Was the worker following the best and safest method of performing his particular job?
3. Had the worker been trained to follow the best and safest method of doing his job?
4. Was he properly supervised?

If, in answering question No. 1, it is discovered that a defective ladder had failed while in service, or that a pick with a split handle had been used, or that the track car had a cracked wheel, there can be no doubt concerning the supervisor's responsibility for the machinery, tools, and equipment involved in the accident. And there is no delay on the part of the supervisor in rectifying such conditions so that similar accidents will not occur.

In considering question No. 2 let me cite an example. Some years ago three men were seriously injured while operating a motor car to which two track cars had been coupled. The motor car was pushing the two track cars. An investigation disclosed that it was much more dangerous to push the cars than to pull them, and as a result it did not take the management long to issue an executive order requiring all trailer cars to be coupled behind instead of ahead of the motor car.

Another example will illustrate the third question. A few weeks ago a new section laborer on a mid-western road fell while operating a track wrench and broke three ribs. He had not braced himself properly and had not been using the wrench in the approved manner. When it slipped he fell against the rail. Unfortunately he had not been instructed by his foreman in the safest and the best method of performing this work.

Opportunity for Foremen

The subject covered by question No. 4 involves an opportunity for straight-thinking foremen to exert a powerful influence for the prevention of accidents. As an illustration, consider the situation where some scrap rail had to be transferred at a junction station which was not a terminal. No power hoist was available, so the foreman decided to transfer the rail by hand. The loaded flat car and an empty car were spotted opposite each other on adjoining side tracks, the loaded car being next to a freight-house platform. Three steel gangways or aprons were laid across between the cars, one at each end and one in the center, for the rails to slide on, being spiked in place. An eight-foot piece of light rail was wedged into a stake pocket near the middle of the empty car on the side farthest from the loaded car, and a snatch block attached to the upper end of the short mast thus formed. A hand winch was placed on the freight-house platform and a light steel cable, with a rail grip attached to the end, was run from the winch through the snatch block on the mast. By winding up the winch, a rail could be dragged across to the empty car. After several rails

had been transferred the foreman decided they could be handled more easily if the mast was higher, so he replaced the 8-ft. piece of rail with one about 13-ft. high. Shortly after this change was made, the iron stake pocket broke out while a rail was being transferred, letting the rail and snatch block fall down on the car. The pulley block struck one of the laborers on the back, severely bruising him, but fortunately breaking no bones.

Where was the foreman at the time this accident happened? If he had been supervising the work properly he would have noted that the mast was inadequately supported and that the work was being conducted in an unsafe manner.

The fifth question to be asked every time an accident occurs is this: Was the worker himself in any way at fault? At first thought, it may seem that every worker who is injured is somewhat at fault for what occurred. It is very simple to state that carelessness is the reason for most accidents—and yet if we go back of that word we find another responsibility for managers and supervisors. It has been learned through many experiences that one of the best ways to combat carelessness is through safety education. And safety education is primarily a problem of leadership, of causing people to form safe instead of unsafe habits, and of teaching by example.

The last question in this series of six is this: How frequently has this man been injured before? If the records reveal that he has been injured more frequently than other workers doing similar work, then the supervisor has revealed a large number of possible activities indicated by the answers to such questions as: Is he ill? Is he worried? Does he have normal eyesight? Is he better fitted for some other job? Finding the right answers to such questions as these and then taking the action that such answers indicate is an opportunity which no foreman will want to sidestep, not only in justice to the man but also in justice to the other workers and to the foreman himself.

Individual Responsibility

There is one other thought which we must not overlook if we wish to attain our next goal in safety. This thought in many respects is a summation of all other plans and efforts. It points to a far-reaching, all inclusive objective which, if attained, will really solve our problem in its entirety. Stated in its simplest terms, this thought is concerned with getting every thinking person to assume his just share of the responsibility not only for his own safety but also for the safety of his associates and others about him.

Accidents present a universal problem, a problem that applies to every walk of life and to every activity in which we participate. This problem confronts every individual just as it confronts every community and every nation. It is everybody's business to see that ships do not sink as did the Vestris; that floods like those around Los Angeles shall not be repeated. It is everyone's task to protect his own life and the lives of his fellow men. Manufacturers must safeguard their products before selling them to the general public; employers must provide safe places in which men can work; engineers must design tools and equipment which are just as safe as it is humanly possible to make them; the public most support the law-making and law-enforcing authorities; workers must follow instructions; and foremen must teach and supervise the men who work under their direction.

Accidents will stop only when each individual accepts personal responsibility for our accident toll. Accidents continue to occur because many of us evade this responsibility. Perhaps we do it unintentionally, but we continue to start fires with kerosene, and to shoot guns that "were not loaded," we still try "to beat" the train to the railroad crossing, and we do many other equally foolish things that frequently end in tragedy. We must learn that accidents do not just happen. In nearly every case they are caused by acts of omission of human beings.

Not long ago in a large shop where flammable vapors were present, an executive of the company attempted to enter while smoking a cigar. The watchman, not aware that this individual was the vice-president, flatly refused him admission until he had deposited the cigar in a metal refuse container provided for that purpose. This gateman fully understood his personal responsibility and lived up to the confidence reposed in him by his employer.

Customs and habits of thought change slowly. Instead, therefore, of becoming discouraged because of the seemingly slow progress that is being made, let us take encouragement from the accomplishments that have thus far been achieved, and re-dedicate ourselves to a cause that today has such a solid foundation and on which tomorrow's effort will build with enduring strength.

Discussion

Following the presentation of his paper, Mr. Long said he wished to pay public tribute to the Roadmasters Association for the excellent work that it has done and added that, in the promotion of safety, the safety department can only make suggestions while it is the men themselves that establish the records. One subdivision on the Delaware & Hudson, he said, had worked 900,000 man-hours during the last three years without a reportable accident. He explained that O. Surprenant (D. & H.) who has made an enviable safety record, holds monthly meetings with his foremen in the interests of safety. By attending these meetings and participating in the discussion, the foremen have become safety-minded and, incidently, have as a rule developed a capacity for expressing their thoughts, both vocally and in writing.

L. M. Denney (C.C.C. & St.L.) remarked that in the promotion of safety, there is nothing more instructive than to get the men together in meetings. He added that a surprisingly large number of excellent ideas on safety are found in papers on this subject written by trackmen.

P. J. McAndrews (C. & N.W.) said that his railroad is still capitalizing on the benefits obtained through meetings of track foremen that were held years ago.

The Track Supply Exhibit

NO convention of the Roadmasters' Association is complete without an exhibit of track materials, tools and work equipment presented by the Track Supply Association. This year, however, the exhibit was of even more than usual interest because of the many new developments that were on display for the first time, and many of those attending the convention made much of this opportunity to become familiar with equipment and materials that they had not been able to study at first hand before. The number of exhibitors presenting displays of appliances and materials this year was 38.

The officers of the Track Supply Association, who were responsible for the preparation and conduct of the exhibit were: President, D. J. Higgins, Gardner-Denver Company, Chicago; vice-president, G. T. Willard, Cleve-

land Tractor Company, St. Louis, Mo.; secretary-treasurer, L. C. Ryan, Oxweld Railroad Service Co., Chicago; directors, L. S. Walker, P. & M. Company, New York; Ward B. Maurer, American Hoist & Derrick Co., Chicago; G. M. Hogan, Sellers Manufacturing Co., Chicago; F. J. Reagan, American Fork & Hoe Co., Chicago; ex-officio, L. P. Shanahan, American Steel & Wire Co., Chicago.

In the election of officers, Mr. Willard was advanced to president; Mr. Reagan was elected vice-president, and Mr. Higgins was elected secretary-treasurer. George E. Johnson, representative, P. & M. Company, Chicago, and Lem Adams, chief engineer, Oxweld Railroad Service, Chicago, were elected directors.

List of Exhibitors

Air Reduction Sales Company, New York; welding and cutting equipment; oxygen and acetylene regulators; carbide lights, lamps and lanterns; welding rods, goggles, built-up and heat-treated rail joints; C. A. Daley, E. M. Sexton, B. N. Law, W. H. Ludington, R. T. Peabody, J. F. Callahan, W. A. Andrews, Jr.; W. H. Handrock, J. W. Kenefic and M. M. Weist.

American Fork & Hoe Company, Cleveland, Ohio; rail anchors, tapered rail-joint shims, shovels, weed cutters, forks, rakes, scuffle hoes and broom rakes; Frank J. Reagan, J. D. Christie, G. L. Dunn, A. F. Fifield, S. L. Henderson, C. E. Irwin, J. J. Nolan, F. C. Stowell and H. C. Branahl.

Austin-Western Road Machinery Company, Aurora, Ill.; models and moving pictures, and literature on dump cars and tractors with railroad attachments; Jess Mossgrove, S. F. Beatty, Jr., H. B. Bushnell, Bruce Smith and J. D. Benbow.

Chipman Chemical Company, Inc., Bound Brook, N. J.; literature on chemical weed killers; J. K. Aiman and N. J. Leavitt.

Conley Frog & Switch Company, Memphis, Tenn.; models of solid manganese expansion rails for bridges and model of solid manganese self-guarded spring frog; J. E. Conley and E. H. Baumgarten.

Duff-Norton Manufacturing Company, Pittsburgh, Pa.; track jacks, journal jacks, automatic lowering jacks and tie spacers; E. E. Thulin and C. H. Thulin.

Eaton Manufacturing Company, Reliance Spring Washer Division, Massillon, Ohio; spring washers; E. D. Cowlin, A. H. Weston, R. L. Shireman and E. C. Gross.

Illinois Malleable Iron Company, Chicago; rail anchors; H. A. Morean, Chas. G. Ericson and W. T. Kelly.

Ingersoll-Rand Company, New York; pneumatic tie tamper, track wrench, rail drill, spike driver, rivet buster, riveting hammer, chipping hammer, holder on, air-line lubricator, safety saw, sump pump, wood borer, screw-spike wrench, clamp bolt wrench, grinders and scaling tool; Wm. H. Armstrong, G. W. Morrow, T. H. Weigand, G. E. Bridge and E. C. Geither.

International-Harvester Company, Chicago; I-12 industrial tractor, and T-40 Diesel power unit; R. M. McCroskey, H. P. Thieman, W. M. Parrish, A. W. Turner, W. F. Hebard, B. C. Cooper, William Hensel and Blake C. Howard.

O. F. Jordan Company, East Chicago, Ind.; model of spreader ditcher; H. M. McFarlane, J. C. Forbes and A. W. Banton.

Kelsey-Hayes Wheel Company, Detroit, Mich.; spring washers; D. J. Crowley, H. G. Jackson and G. A. DeLisle.

Lundie Engineering Corporation, New York; tie plates and rail lubricator; Eugene Brandeis, L. B. Armstrong and C. E. Irwin.

Maintenance Equipment Company, Chicago; switch point protector, rail and flange lubricator, model of friction car stop and literature on power tools, lubricators and fence posts; T. E. Rodman, D. M. Clarke, E. Overmier, R. J. Shanahan and A. J. Frystak.

Mall Tool Co., Chicago; portable rail grinders and flexible-shaft cross-grinding and nut-setting equipment; A. W. Mall and O. H. Dallman.

Morden Frog & Crossing Works, Chicago; heat-treated forged compromise joints, adjustable rail braces and miscellaneous forged fittings for switches; E. C. Argust, G. F. Killmer, Sam Withrow and R. A. Brown.

National Lock Washer Company, Newark, N. J.; spring washers and literature; W. R. Hillary, G. L. R. Masters, R. L. Cairncross and F. D. Archibald.

Nordberg Manufacturing Company, Milwaukee, Wis.; rail grinders, power wrench, utility grinders and accessories; H. H. Talboys, W. W. Fitzpatrick and C. P. Clemmens.

Oxweld Railroad Service Company, Chicago; oxy-acetylene welding and cutting apparatus; L. C. Ryan, Lem Adams, J. E. Winslow and W. H. Kofmehl.

P & M Company, Chicago; rail anti-creepers and bond-wire protectors; D. T. Hallberg, W. A. Maxwell, J. E. Mahoney, G. E. Webster, G. E. Johnson and J. J. Gallagher.

Pettibone Mulliken Company, Chicago; switch stands, switch point lock, mechanical switchman and heel filler; G. J. Slibeck, J. B. Campbell, G. R. Lyman, T. B. Nash, C. Johnson and C. F. Landberg.

Pocket List of Railroad Officials, New York; copies of Pocket List of Railroad Officials; J. Alexander Brown and B. J. Wilson.

Positive Rail Anchor Company, Chicago; rail anchors and guard-rail plates and braces, adjustable rail braces, adjustable track wrench and reflectorized railroad signs; A. H. Told, L. C. Ferguson, J. Imhoff, J. Larson and D. Willard.

Rail Joint Company, New York; insulated and standard rail joints; E. A. Condit, Alex Chapan, C. B. Griffin, Harry C. Hickey, G. H. Larson and Thomas Ryan.

Railroad Accessories Corporation, New York; moving picture of power track machine; S. G. Ellis.

Railway Engineering and Maintenance, Chicago; copies of RAILWAY ENGINEERING AND MAINTENANCE and Railway Age; Henry Lee, C. R. Mills, F. H. Thompson, Elmer T. Howson, F. C. Koch, W. S. Lacher, H. A. Morrison, J. G. Little, C. J. Wageman, G. E. Boyd, H. E. McCandless, M. H. Dick, Charles Packard and S. W. Hickey.

Railway Purchases & Stores, Chicago; copies of Railway Purchases and Stores; Edward Wray, K. F. Sheeran and J. P. Murphy.

Railway Track-Work Company, Philadelphia, Pa.; portable electric track grinder, portable stock-rail grinder, rail-joint cross grinder, portable reciprocating grinder, portable flexible shaft grinder and grinding wheels; A. M. Nardini and Henry Perazzoli.

Ramapo Ajax Corporation, New York; full-size model highway crossing, Samson switch points, switch stands, guard rail clamp, adjustable rail brace, limit gage, Eureka clips, port-a-fount sanitary water carrier, reversible manganese steel crossing and gage rods; J. B. Strong, J. E. Davidson, G. M. Cooper, G. A. Carlson, R. E. Einstein, D. Fairback, W. Fairback, D. F. Hilton, P. Hoffman, J. S. Hutchins, A. F. Huber, H. W. Renick and W. Perdue.

Sellers Manufacturing Company, Chicago; wrought iron tie plates, and angle bars; G. M. Hogan, R. J. Platt, R. A. Van Houten and J. T. Flynn.

Sinclair Refining Company, Headley Asphalt Division, New York; emulsified asphalt; W. T. Gilbert, W. T. Reece, Walton Collins and W. D. Achuff.

Frank Speno Railroad Ballast Cleaning Co., Inc., Ithaca, N. Y.; literature, photographs and moving pictures of ballast cleaning operation; Frank Speno, Jr. and Thomas Speno.

Sperry Rail Service, New York; moving picture of testing rails in track with Sperry detector cars, exhibit of transverse fissured rail sections, and track recording device; C. W. Gennet, Jr., J. A. Drain, Jr., Andrew Stewart, E. A. Crawford and J. D. Williams.

Standard Equipments, Inc., New York; rail joint assembly forging sequence, joint crown instrument; C. O. Bradshaw, A. E. Hill and E. W. Backes.

Teleweld, Inc., Chicago; rail joint shims, samples of welded rails showing effects of pre-heating, samples of heat treated rail and field hardness testing kit; A. M. Wood and T. L. Borman.

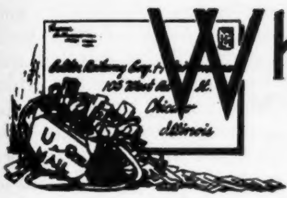
Templeton, Kenly & Co., Chicago; jacks, G-Y tie spacer and rail puller expander; George L. Mayer, Chas. Neher, W. B. Templeton and W. C. Cornu.

White Manufacturing Company, Elkhart, Ind.; gas and oil burning switch heaters, kerosene torches. concrete vibrators and concrete guns; W. McK. White and C. L. Dewey.

Woodings-Verona Tool Works, and Woodings Forge & Tool Company, Verona, Pa.; rail anchors, gaging tool, track levels and gages, track jacks, nut locks, triflex springs and tie plates; R. J. McComb, James McComb, E. Woodings, R. T. Woodings, W. H. Woodings and A. C. Laessig.

Non-Exhibiting Members

American Hoist & Derrick Company, St. Paul, Minn.
American Steel & Wire Company, Chicago.
Cleveland Tractor Company, Cleveland, Ohio.
Creepcheck Company, Inc., Chicago.
Cullen-Friedstedt Company, Chicago.
Electric Tamper & Equipment Company, Ludington, Mich.
Fairmont Railway Motors, Inc., Fairmont, Minn.
Gardner-Denver Company, Chicago.
Industrial Brownhoist Company, Cleveland, Ohio.
Keystone Grinder & Manufacturing Co., Pittsburgh, Pa.
Maloney Oil & Manufacturing Co., Scranton, Pa.
Northwestern Motor Company, Eau Claire, Wis.
Ohio Power Shovel Company, Lima, Ohio.
S. E. Rawls Company, Streator, Ill.
Q & C Company, New York.



What's the Answer?

Send your answers to any of the questions to the What's the Answer editor. He will welcome also any questions that you may wish to have discussed.

To Be Answered in December

1. *Should hardwood or softwood tie plugs be used with softwood ties? With hardwood ties? Why?*

2. *Where drift bolts cannot be pulled from stringers or caps with a clawbar, what other means can be employed to remove them without damaging the timber?*

3. *What special provisions should be made at this season to insure adequate surface drainage and prevent the accumulation of ice around isolated switches during the winter? Around ladder and other yard switches?*

4. *What are the advantages of triplex pumps as compared with duplex-reciprocating and centrifugal pumps for railway water service? For what conditions are they particularly adapted?*

5. *What are the advantages of double-shoulder tie plates as compared with single shoulder? The disadvantages? What effect, if any, do they have on maintenance?*

6. *What are the causes of failure in built-up waterproofing? What can be done to eliminate or minimize these failures?*

7. *What action, if any, can the track forces take at this time to minimize heaving during the winter?*

8. *To what extent can building hardware be standardized? What are the advantages? The disadvantages?*

Tools for Tie Inspection

When inspecting ties for renewal, what tools should be used and in what way? Do the tools and methods of use differ for treated and untreated ties?

Can Be Inspected Without Using Tools

By W. H. SPARKS

General Inspector of Track, Chesapeake & Ohio, Russell, Ky.

A supervisor and a section foreman who know timber and have had the track experience that their positions demand can inspect ties without using any tools. An inspection of the ends of the ties, of the tops and of the sections immediately under the rail will give all of the information needed to judge of the soundness of the timber. Obviously, some ties will look bad enough to come out, which will be found to be in sufficiently good condition to run a year or two when the track is opened up for surfacing or making renewals. On the other hand, occasional ties will be passed over which will be found to have failed, when the track is opened. But experience has shown that these cases substantially offset each other in the long run. We have been making our inspections in this way for many years, and we find that we are able to maintain excellent tie conditions without making excessive renewals.

Tools Are Small Lining Bar and Pick

By H. T. LIVINGSTON

Division Engineer, Chicago, Rock Island & Pacific, Little Rock, Ark.

A small lining bar and a pick constitute the proper tools for inspecting ties. The lining bar is used to test the strength of the tie by prying up at its end; the pick to remove the ballast where necessary and to provide a fulcrum for the bar. Where the ballast is flush with the top of the tie, more than a casual inspection may be required to determine its condition. Where a full ballast section is maintained, ties usually fail under the rail; in unballasted track they generally fail at the center. Treated ties are prone to fail under the rail, as a result of center rot which can usually be traced to the entrance of water through the spike holes. Untreated ties fail in larger numbers in the center of the track because they are kept moist by the surrounding earth.

For inspecting untreated ties that have not actually broken, a light bar may be used to determine the extent of the decay. The use of this tool does not cause damage in such ties proportionate to that it will cause in making a similar exploration of treated ties. Treatment seldom reaches to the heart of large ties, such as switch and head-block ties, with the result that in many cases they are subject to center rot. It is particularly important that head-block ties be sound throughout, and where there is reason to suspect that they have only a shell of sound wood, the inspection should be made with an auger. If a tie is found to be sound, the hole should be properly plugged immediately after the inspection.

It is my experience that a foreman and two men can inspect from two to four miles of track in an eight-hour day, depending on the number of doubtful ties which must be given detailed inspection and tested.

A Clay Pick Is Usually Sufficient

By E. L. BANION

Roadmaster, Atchison, Topeka & Santa Fe, Independence, Kan.

When inspecting ties for renewal, I consider a light clay pick sufficient, as any desired test for failed timber can be made with this tool. It has been found that hardwood ties and those of other woods that do not take heart treatment readily, will develop heart rot and yet to all outward appearance be sound. Failures of this type can be detected by sounding, that is, by dropping the butt of the pick on the tie. If a cavity or internal decay is present, it will be indicated by a hollow sound. Such failures can sometimes be discovered by inspecting the ends of the tie, but usually there is no surface indication of failure.

Ties that fail from crushing under the tie plate usually show indications of brooming around the plate, while the spikes are lifted by the wave action of the rail under traffic. It is my experience that internal decay is the

only type of failure that requires the use of a tool to detect, as practically all other forms of failure can be discovered by close visual examination.

In making tie inspections, it has been my custom to have two laborers sound the ties, dig the ballast away from the ends, try the spikes and make any other test thought necessary to determine the actual condition of the ties. At present, however, on light traffic lines handling only a small part of their normal business, and working under deferred maintenance conditions, good judgment must be exercised in selecting ties for renewal. It is not so much a question of how many are needed, according to past renewal practice, but what is the least number that will maintain the necessary margin of safety for that particular territory.

Sounding Only on Treated Ties

By L. G. BYRD
Supervisor of Bridges and Buildings, Missouri Pacific, Poplar Bluff, Mo.

Based on my own experience in inspecting ties, the best tool for the purpose is a 5/8-in. bar about 4 1/2 or 5 ft. long, having a chisel point at one end and a ball about 2 in. in diameter at the other. The ball end can be used for sounding ties for surface decay that is not readily apparent and for heart decay. The chisel end is used around tie plates and for springing the spikes to detect decay in the holes, or spike-cut ties. Treated ties that change from dark to light in color should be examined closely for decay, although most treated ties fail from mechanical abuse under the rail. Treated ties should never be punctured but only sounded.

Only Doubtful Ties Require Tools

By W. E. TILLETT
Assistant Foreman, Chesapeake & Ohio, Maysville, Ky.

Visual inspection will detect most of the failed ties in any stretch of track, with the exception of those that have been so abused by tamping that the bottoms are virtually round. I favor the use of a pick and a half-inch steel bar with a point on one end and a chisel point on the other, for inspecting the doubtful ties. The pick is used to remove ballast and to sound suspicious ties for interior decay, while the bar is used to examine conditions around the spikes. With this equipment, an experienced trackman should be able to make a thoroughly dependable inspection, the results of which will vary only slightly from the conditions found when the track is opened for making the renewals.

Finds a Pick Handle Sufficient

By J. MORGAN
Supervisor, Central of Georgia, Leeds, Ala.

I find a pick handle to be an excellent aid in making tie inspections. The bulk of the ties that require renewal can be detected easily and quickly by visual inspection. Certainly no tool is needed to discover a broken tie or one that is badly spike cut. Where there is doubt as to the soundness of the wood below the surface, the pick handle can be dropped vertically and the character of the sound as the end strikes the tie will at once disclose to an experienced trackman whether the wood is decayed or sound. In other words, I want to stress the fact that no amount of tool equipment can offset the judgment of an experienced trackman in making a tie inspection. For example, a softwood tie may be badly plate cut and yet be good for several years' service. An inexperienced man would probably spot it for renewal, while an experienced one would adze it to remove the shoulder and then apply creosote to the cut surfaces. Again, a tie that is crushing under the plate will be detected and marked for renewal by the experienced trackman while an inexperienced inspector may pass it unnoticed. In neither case, however, is a tool needed to detect the failure. Only through long experience in tie renewals does one arrive at the point where he can be depended on to know the proper relation between the factors of safety and cost in renewing ties.

A Pick Will Give All Necessary Information

By ROBERT WHITE
Section Foreman, Grand Trunk Western, Drayton Plains, Mich.

I have never found it necessary to use any tool other than a pick for making tie inspections. This is not to be stuck into the tie to tear it to pieces so that it must be renewed, as is too often done, but to remove the ballast from the ends or sides sufficiently to "feel" the bottom for decay. I also use it for sounding for heart decay, for detecting broken ties and to determine whether there is decay at the spike holes. It is only the doubtful ties that must be given such detailed inspection; most failed ties can be detected by visual inspection only.

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Treated Timbers As Bolsters

Under what conditions, if any, is it good practice to use treated timbers as bolsters, or blocking, under the shoes of steel spans to effect a raise in grade, provided this can be done without exceeding the strength of the timber across the grain? If so, what are the limitations? If not, what alternate method should be followed?

Wood Blocking Only a Temporary Expedient

By JOHN L. VOGEL
Bridge Engineer, Delaware, Lackawanna & Western, Hoboken, N. J.

It is not generally considered good practice to use treated timber for bolsters, or blocking, under the shoes of steel spans to effect a raise in grade, if the blocking is to be permanent. Wood blocking is used as a temporary expedient in many cases, but it is not necessary to treat it for this purpose, since the wood is always replaced within a short time by cast-steel blocks, by steel slabs, by I-beam bridges or new cast-steel pedestals, depending on the amount of the raise, the design of the original pedestal and the condition of the masonry.

Not Unless Substructure Is of Timber

By C. A. JOHNSTON
Superintendent, Wabash, St. Louis, Mo.

Timber should be used as blocking under steel spans as a temporary measure only. Occasionally, however, it is necessary to maintain steel spans on timber bents, in which case it is permissible to make the raise on timber blocking. Where the steel superstructure is supported on masonry, timber should not be inserted permanently between the steel and the masonry. Such use of timber requires frequent inspection to insure that the blocking is in good condition, and frequently results in poor-riding conditions.

Wherever steel spans on masonry substructures are to be raised, the construction of permanent blocking is justified. In the event the raise is sufficient to allow

the construction of concrete pedestals, either precast or in place, this should be done, making sure, however, that the reinforcing is sufficient to insure that the blocks will not crack or crush. Where the raise is light, shims can be constructed of steel plates. If somewhat greater, they can be made of steel plates and shapes or of plates and second-hand rail. With the welding equipment that is now available on most roads, it is an easy matter to fabricate steel blocking for bridge raises.

Does Not Consider It Good Practice

By G. A. HAGGANDER
Bridge Engineer, Chicago, Burlington & Quincy, Chicago

It is not considered to be the best practice to use treated timbers as bolsters, or blocking, under the shoes of steel spans to effect a raise in grade, when the superstructure is supported on stone or concrete masonry substructures, especially on heavy-traffic main lines. Usually the sizes of the bearings are such that some crushing of the timber will occur, and it is rather difficult to obtain a firm anchorage for the span. The usual practice is to substitute built-up steel raising blocks for the timber.

On light-traffic lines, where the substructures are of timber, raises are usually made by means of treated-timber bolsters, or blocking. It is also our practice to use timber blocking temporarily on main-line structures, but we invariably replace the timber with steel raising blocks within a short time.

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Outlet Pipes Through Dams

What precautions should be observed in placing outlet pipes through earth dams? Should the control valve be placed at the upper or lower end of the pipe? Why?

Water Tightness Most Important Consideration

By E. M. GRIME
Engineer Water Service, Northern Pacific, St. Paul, Minn.

In the construction of an earth dam, the most important consideration is that it shall be as nearly water tight as possible. To that end, even in an ordinary earth dam, it is common practice to provide some sort of an impervious core wall extending from a level well below the original ground surface up into the mass of the dam, to a point above the surface to cut off effectually any water that might, under pressure, tend to seep through along the original surface of the ground. Where an outlet pipe passes through the dam, usually at the original elevation of the floor of the valley, there is a continuous line of demarcation between the earth and the pipe. For this reason, the greatest care should be exercised to make certain that the earth is packed solidly around the pipe to prevent any leakage from following the pipe line. If impervious clay is available, several cut-off sections of clay packed around the pipe may be advisable.

Invariably, the control valve should be placed at the up-stream end of the pipe. In this way there will be no water pressure on the line except when it is in use. There is always the possibility of some settlement in the mass of the dam which may cause breakage or slight displacement of the pipe and allow leakage which, under pressure of the head in the reservoir, may soften the interior of the earthen mass to the point where failure of the structure may result eventually.

In the construction of dams, it is good practice to place the spillway through solid earth or rock beyond one end of the dam and, in the same manner, instead of having the outlet pipe pass through the dam, provided conditions are favorable, it may be better to have it pass through the original ground around one end rather than directly through the dam. Even where this is done, however, it is still most desirable to locate the control valve at the upper end.

Eliminate Planes of Cleavage

By Assistant Engineer of Construction

More than one dam failure can be attributed to carelessness during construction or to ignorance of the fundamental fact that water under pressure will seep along any plane of cleavage, no matter how tightly the two surfaces may be pressed together, and of the further fact that such seepage will eventually enlarge the channel which it finds possible to follow, regardless of how small it may have been originally.

Bearing these facts in mind, it is obvious that extreme care should be exercised in placing outlet pipes through earth dams, to insure against failure of the earthen mass. The prime objective should be to secure a bond between the pipe and the earth. The difficulty encountered in doing this is enhanced by the fact that such pipes are usually of cast iron with smooth hard surfaces, and are generally placed at approximately the lowest point of the reservoir where they are subject to the maximum head at all water stages. To insure against displacement of the pipe, it should be provided with a firm foundation in the natural ground and to prevent seepage it should be covered with well-tamped impervious clay of a type that will adhere to the surface of the pipe. As a further precaution, a series of concrete collars, which should also be packed in impervious clay, placed at intervals along the pipe line, will also tend to retard seepage.

Control valves should always be located at the upper end of outlet pipes, to keep them clear of water under pressure except when they are in use.

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What Interval Between Raises?

When renewing ballast, where two lifts are necessary, what interval should elapse between the first and final lifts? Why? What should be the maximum raise on the second life? Why?

Allow As Much Time As Practicable

By K. H. HANGER
Engineer Maintenance of Way, Missouri-Kansas-Texas, Dallas, Texas

It is desirable to permit traffic to settle and solidify the ballast applied in the first lift, so that the minimum settlement will occur after the final surfacing has been completed. For this reason, it is desirable to allow the maximum reasonable interval permissible with relation to the traffic handled over the line involved.

With respect to the maximum desirable raise for the second lift, this should not greatly exceed the dimension restriction on the largest size of ballast particles used, since a raise of this magnitude will readily permit adequate tamping under the ties. A greater raise will be less stable, while it will require more tamping; and a lighter raise will be less satisfactory by reason of the difficulty of getting the maximum sizes of ballast under the ties.

Four Days Is Ample Time

By J. MORGAN
Supervisor, Central of Georgia, Leeds, Ala.

A first lift should be made with the same care and the same effort to obtain a smooth surface as the final lift, although the tamping can be done with shovels if it is properly supervised to insure uniformity. An interval of several days should then elapse, four should be sufficient under ordinary conditions, to give traffic an opportunity to compact the ballast and develop the presence of any weak spots that may exist.

I consider four inches the maximum practical raise for the final lift in any kind of ballast, although two to two and one-half inches is better. Two-inch stone or slag will settle very little under a four-inch lift, provided it is well tamped by hand or machine, if the first lift has been allowed to become well compacted under traffic before the final lift is made.

Allow for Slight Settlement in Final Lift

By W. E. TILLETT
Assistant Foreman, Chesapeake & Ohio, Maysville, Ky.

In giving the track a general raise on new ballast, traffic must always be depended on to compact the first and highest lift, since no amount of tamping will do so, regardless of the kind of ballast used. Care should be exercised, however, to insure that such tamping as is necessary is done uniformly so that the track will settle evenly. Carelessness in this part of the work may damage the rails through surface bending, while it will add to the difficulty of getting a smooth surface on the final lift. Two or three days are usually required to obtain full settlement, after which the average raise should be 2¼ in., the ¼ in. being an allowance for settlement which invariably occurs in the final lift, even where the ties are tamped solidly.

Interval Depends on Volume of Traffic

By F. S. HALES
Engineer of Track, New York, Chicago & St. Louis, Cleveland, Ohio

In general, the interval that should elapse between the first and final lifts, where two lifts are necessary, depends upon the amount of traffic. Where traffic is light, there should be more elapsed time than where it is heavy. On the first lift, which is usually about six to eight inches, the track cannot be tamped by hand to get the stone fully compacted. It is necessary, therefore, to depend in large measure upon traffic to do this. Generally speaking, I would say that about three days should be allowed as the minimum elapsed time between the first and final lifts. The raise on the final lift should range between one and two inches. Experience has shown this to be the best lift to insure proper tamping, after the ballast in the first lift has been properly compacted under traffic.

Total Raise Is Determining Factor

By W. H. SPARKS
General Inspector of Track, Chesapeake & Ohio, Russell, Ky.

In general, the total raise will gage both the height of the second lift and the time that should elapse between the first and final lifts. For example, if the total raise is six inches, the first lift should be about 4 to 4½ in., in which case the final lift will not be less than 1½ in. or more than 2 in., depending on the type of ballast employed. On the other hand, if the total raise is to be 12 in., the first raise should be 11 in., and the tamping should be done with shovels or ballast forks. After the ballast has been compacted by traffic, it will be found generally that the final lift will average around three inches, although this will vary some with the character of the ballast used and the care with which the first tamping is done.

Sufficient time should be allowed between the first and final lifts to insure that the first application has been fully compacted and that all weak places have developed. This interval will depend on the character of the ballast, the magnitude of the lift, and the character and density of the traffic. The second lift should be tamped with picks or mechanical tampers to insure the immediate compacting of the ballast as well as a smooth surface.

Two Inches Gives Best Results

By HENRY BECKER
Section Foreman, St. Louis-San Francisco, Rush Tower, Mo.

In my judgment, based on long experience, an interval sufficient to allow complete settlement of the ballast first applied should elapse before the final raise is made. Where a raise of more than four inches is necessary, no amount of hand or machine tamping will compact the ballast enough to prevent settlement under traffic. For this reason, shovel tamping is sufficient for the first lift, provided every care is exercised to insure that a uniform job is obtained. Experience has shown that traffic will compact the ballast so that little settlement will occur when the final lift is made, provided good and uniform tamping is done at this time also. The proper interval between lifts will depend on the volume and character of the traffic on the line as well as the character of the ballast. If the job has been well done, two inches is about the proper lift for the final surfacing.

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Distributing Small Material

When laying rail, how far in advance of the various operations should materials, such as bolts, spikes, tie plugs, tie plates, anti-creepers, etc., be distributed? What check can be kept on the distribution of these materials?

Should Be Done One Day in Advance

By J. J. BAXTER
Assistant Chief Engineer, Wabash, St. Louis, Mo.

When laying rail, all materials should be unloaded and distributed by the same work train that unloads the rail. When this method of distributing the other track material is followed, it is important that care be used in unloading the rail so that the individual rails will lay along the shoulder as nearly as possible directly opposite their final location in the track. Then, as the rail unloading proceeds, a pair of angle bars should be unloaded at each new joint and kegs of bolts and spikes and packages of anchors, tie plugs, tie plates, etc., dropped in equal quantities on each side of the track at predetermined intervals.

Men should follow the unloading train and pick up whatever packages may have rolled down the bank, set the bolt and spike kegs up on end and lay the angle bars by pairs at the rail ends so that they will be readily available for attaching to the rail ends ahead of the rail laying.

The kegs and packages of materials should not be opened until the day before the work of actual rail renewal. On that day men should work ahead of the rail

gang and make accurate distribution of the material by placing the required pieces of the various items at about the center of the track directly opposite the joint where they will be used. This operation should be only for one line of rail; the operation to be repeated the day before the other line of rail is laid.

By this method of distribution, any shortage of materials will be discovered in plenty of time to enable the items that are short to be secured. However, if the foreman has supervised the unloading work carefully and instructed his men properly as to the intervals at which the various classes of materials are to be distributed, there should not be any shortage. In fact, it is better to have a slight surplus of material which may be carried forward as the rail laying proceeds.

The unloading of frog and switch material should be made an entirely separate operation. This material should be unloaded at the site of the switch, carefully sorted and checked, and stored in such position that it can be readily handled by the rail laying gang.

Avoid Delaying the Work

By F. S. HALES
Engineer of Track, New York, Chicago & St. Louis, Cleveland, Ohio

Probably the simplest answer to this question is that these materials should be distributed far enough in advance of the rail gang so that the work will not be delayed. The actual distance in advance depends entirely upon the size of the gang and the amount of traffic, or in other words, the speed which the gang makes, and will vary for various gangs and under various conditions of traffic. I do not believe there is any set rule which can be applied either with respect to the number of days of work or the number of feet of track in advance, the answer simply being that the rail gang should not be delayed. We generally order such track material a month ahead of the rail so as to be sure to have it on hand when the rail arrives and, in this way, we are able to proceed with the rail laying immediately upon receipt of the rail. A check on the distribution of these materials can be made by the supervisor keeping a record of the material required per mile of track and noting when a certain item has been distributed on each mile.

About One-Half Mile in Advance

By O. H. CARPENTER
Roadmaster, Union Pacific, Rawlins, Wyo.

I have found it advantageous to distribute the fastenings in bulk at the same time and with the same train that is used for unloading the rail. When the train stops to unload a rail, enough fastenings should be dropped off for one rail panel, except bolts, spikes and spring washers, which come in boxes and kegs. These packages should be dropped off at the proper intervals, which can be calculated in advance.

This train should be far enough in advance of the rail gang to insure so that the gang will not be delayed, and so that movements to clear traffic will not be made through the gang. I prefer to have the work train at least five miles ahead of the gang and if the stretch of new rail is 10 miles or less, I unload all material before the work of laying is started. If the renewal is made during the winter, however, this may not be practicable because of the danger of much of the material becoming lost in snow. In this case the primary distribution should be made on the same day that the rail is to be laid.

In making the detailed distribution, I find it advantageous to use a small gang of, say, eight men, with a push car, working from one-fourth to one-half mile in advance of the rail gang, to place each item of material, except joint bars, between the rails at the points where they will be needed. The joint bars are left on the shoulder of the ballast.

An accurate check of the material can be kept as it is unloaded, and a similar check made of the material after it is applied so that a complete accounting of all the material involved can be made without difficulty.

As Short a Time Before As Practicable

By THOMAS WALKER
Roadmaster, Louisville & Nashville, Evansville, Ind.

Fastenings for new rail should be distributed as short an interval in advance of the actual laying as is practicable. This time may vary with local conditions and the amount of rail to be laid, but in general, I would say that one day in advance should be ample. If the material is distributed too far in advance, some of it may be lost, covered up or stolen. The principal factor is, however, the danger that small boys who may be trespassing on the track may place some of the small fastenings on the rail. This happens too frequently and I have personal knowledge of several derailments that were caused in this way. Some designs of anti-creepers are particularly dangerous as they can be hooked over the top of the rail.

If the proper amount of material is distributed, this is an automatic check and I believe that no further action is necessary. Obviously, the foreman who does the unloading should keep an accurate check of the materials he distributes, likewise the section foreman should know how much is needed for the rail, and these two should balance.

While the proper time for distributing the fastenings may vary owing to differences in rail-laying practices, in general, the time should be as short as practicable. Furthermore, the released fastenings should be picked up immediately after the rail is laid.

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Fastening Tie Plates

Where tie plates are fastened to the ties independently of the rail fastenings, should the lag screws be applied at the time the plates are installed or at a later date? Why? If the latter, what interval should elapse?

Give Plates Time to Settle

By W. H. SPARKS
General Inspector of Track, Chesapeake & Ohio, Russell, Ky.

In studying this question, several points must be taken into consideration, including whether the track is to be gaged at the time of applying the plates; whether, in the settling of the plates, it will remain in gage; whether the plates are applied with the shoulder fitting snugly throughout its length against the rail base; and whether the ties are properly spaced and at right angles to the track. Obviously the lag screws should not be inserted until the track is gaged correctly, although if the ties are prebored, as they should be, this will be taken care of automatically. On the other hand, if the plates, particularly if they have any form of corrugations on the bottom, are allowed to get their initial settlement under high-speed movement, they are quite likely to settle in such a way as to make the gage irregular. The remedy for this is to require trains to pass over them at low

speed until they are sufficiently embedded to insure that the remainder of the settlement will occur without affecting the gage. Likewise, the lag screws should not be inserted unless the plates are straight and are in correct position relative to the rail, or in ties that are not straight and properly spaced.

From observation, I am convinced that where the rail fastening is a cut spike, there is an advantage in waiting until the tie plates have become fully seated before the lag screws are inserted. The interval that should elapse will vary with the kind of ties in service, the design of the bottom of the plate and the density of traffic on the line, so that it cannot be stated specifically.

Would Apply Lag Screws Immediately

By O. H. CARPENTER

Roadmaster, Union Pacific, Rawlins, Wyo.

Lag screws should be applied at the time the tie plates are installed. Where the installation is being made in connection with rail renewal, the ties should be carefully adzed to an even surface, preferably with adzing machines, which will afford a full bearing for the plates. Then as soon as the plates are applied and the rail is brought to gage, the holes should be bored for the screws and the screws inserted at once.

If the screws are not applied immediately, it will be necessary to devise some other method for holding the plates in place until they are applied. This can be done by driving cut spikes at the ends of the plates to hold the track to gage, but this requires extra work and the cut spikes will damage the ties unnecessarily. The only argument that I can conceive of in favor of waiting for some time before applying the lag screws is that it will allow the plates to become seated before they are fastened down.

Where the screws are applied at the time the plates are installed, there will be some settlement of the plates into the ties, allowing some play between the tie and the plate. This will amount to very little, provided a good job of adzing has been done, and can be corrected by going over the track and tightening the screws. This will be better than fastening the plates by some other method and applying the screws later.

Where the ties are adzed and bored at the treating plant, it is a good plan to apply the plates to the ties at the time they are adzed. This will eliminate the delay in doing the work in the field and, where power machines are employed for applying the screws, it will also eliminate the necessity for flagmen and the delays to the work incident to traffic. When applying lag screws, care should be exercised to insure that they are not driven to the point where the threads will cut the fibres of the wood, this being comparatively easy to do in softwood ties.

Immediate Application Wastes Time and Labor

By I. H. SCHRAM

Engineer Maintenance of Way, Erie, Jersey City, N. J.

To apply the lag screws at the time the plates are installed, or before they have become fully seated on the ties, is to waste both time and labor, since the initial seating of the plates will make it necessary to go back over the track within a short time to turn the lag screws down for the purpose of taking up the play that results. If the lagging of the plates is delayed until they have had an opportunity to become fully seated, this additional work will be avoided.

It is obvious that the time interval between the application of the plates and the insertion of the lag screws depends upon several factors, including the kind of wood in the ties, the size of the plates used, the character of the bottom of the plates and the volume of traffic passing over them. Assuming heavy traffic, hardwood ties and anchor-bottom plates, the interval required for the plates to seat themselves fully, ranges from two to three months. If the plates have flat bottoms, the time will be slightly longer, while if the plates have transverse ribs, the time will be still longer. The reason for this is that the wood fibres beneath the remainder of the plate do not begin to compress until the ribs themselves have become well seated. In no event, regardless of the bottom design, should the lag screws be applied until the plates are fully seated.

When applying the lag screws, the use of good coil-spring washers between the plates and the heads of the screws is desirable, since they absorb any lost motion that may develop as a result of the further seating of the plates. In practice, it has been found that where coil-spring washers are used, further tightening of the lags is unnecessary for two or three years after their application and that a second tightening at the end of this period will usually keep the plates tight on the ties practically for the remaining life of the ties. The reason for this is that the tight fit of the plates practically eliminates abrasion of the wood beneath the plates, which, assuming that the plates are of adequate size, is the principal cause of tie wear and the resultant sinking of the plates into the ties.

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Pointing Stone Masonry

What methods should be employed and what precautions should be observed when pointing old stone masonry? What kind of mortar should be used? How should it be applied?

Finds Cement Gun Most Valuable

By CHARLES P. DISNEY

Bridge Engineer, Canadian National, Toronto, Ont.

I have seen literally hundreds of old stone masonry piers, abutments, pedestals, culverts, etc., that have been pointed by the old slipshod method of hand pointing. To my mind this has merely provided an easy pastime for the bridge and building forces. In fact, I would go so far as to say that practically every cent of the money spent for this purpose has been wasted on both our own and every other railway on which I have seen hand pointing done. I arrived at this conclusion about five years ago after observing that practically none of the pointing done to structures on this region has lasted more than three years and seldom longer than through the first winter.

Having reached this conclusion, I set about to find some way of doing the work without wasting the money it cost to do it. As a result of this study, hand pointing of masonry is now forbidden on the Central region of this road and pointing is now done with the cement gun, the joints first being raked clean. In some cases we have a special nozzle which is flattened. We have also invariably found it necessary to reduce the normal nozzle pressure to prevent the spreading of the gunite.

In many cases we find that the gunite goes well into the interior of the structure, since the majority of these so-called masonry structures consist of a facing course of cut stone backed up with what I would class as rubble

with a little mortar thrown in. By the use of the cement gun we are able to get a considerable volume of the gunite into this part of the structure with a resultant increase in strength. From the results we have obtained to date we believe that the work is practically permanent and will last as long as the structure itself. We also find that the pointing can be done much more quickly and, therefore, more cheaply than by hand.

For this class of work we use a mixture of one part of cement and three parts of sand, the water being controlled at the nozzle. At present we are doing large jobs of pointing on high masonry piers all over the system. It is surprising the amount of pointing that can be done in a season by a competent bridge gang trained in this work.

Mortar Should Be Forced Into Joint

By Supervisor of Bridges and Buildings

Stone masonry that would otherwise have long life may be severely damaged by the loss of mortar from the joints by frost action or other causes. It is important, therefore, to keep the joints well pointed. In preparation for this work, the joints should be cleaned thoroughly to a depth of one inch or more, all loose particles being raked out. The surfaces should then be flushed with water and the pointing done with a reasonably dry mortar, composed of one part of portland cement and two parts of sand, to which about 15 per cent of slaked lime has been added. As the application is made, the mortar should be driven into the joint with a suitable tool and compacted, this part of the operation being important.

If there are numerous or large voids back of the facing course, as often occurs in old stone structures, these voids should be filled by grouting, under pressure if necessary. A properly handled job of pointing and grouting should preserve the structure so that its life will be extended indefinitely.

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Lead Pipe for Plumbing

What are the relative advantages and disadvantages of lead and wrought iron or steel pipe in plumbing installations?

Lead Pipe Adaptable for Service Connections

By C. R. KNOWLES

Superintendent Water Service, Illinois Central, Chicago

Lead has long been considered an acceptable material for the construction of service pipes. Among its advantages are its resistance to corrosion and incrustation. It is particularly adapted for making service connections in places where it can be shaped or bent to avoid obstructions or to meet other conditions which might interfere with the installation of rigid pipe constructed of other materials.

Under normal conditions lead pipe is very durable and has longer life than pipe constructed of any other material except copper or brass. As evidence of the truth of this statement, lead pipe installed in Rome before the Christian era has been unearthed during excavations and found to be in an excellent state of preservation. It also has a high salvage value. Lead pipe is softer than pipe made from other materials, for which reason it is more easily damaged, although recent improvements in the composition of the lead, through the introduction of about 0.1 per cent of tellurium, have resulted in the development of pipe of higher strength and greater resistance to damage. There have been cases where lead pipe has been damaged by galvanic action. This has been attributed, in part at least, to conditions set up where "wiped" joints were used. In rare cases and under certain peculiar water conditions, lead pipe has also been the cause of lead poisoning.

In the past, lead pipe has been used extensively for plumbing installations, but as improvements have been made in pipe made from other materials, copper, brass, etc., have largely supplanted it. At present its use is confined largely to connections between mains and service lines; in fact some city ordinances require that such connections be made with lead pipe.

Lead Pipe Now Seldom Used

By L. L. TALLYN

Division Engineer, Delaware, Lackawanna & Western, Hoboken, N. J.

In recent years the use of lead pipe has been practically eliminated in plumbing installations and at present it is not used to any extent except on waste connections. The best material for plumbing installations is copper or brass. Considering the relative merits of wrought iron and steel pipe, it is our experience that wrought iron has a longer life in service owing to the fact that it is not affected by corrosion. This is particularly true where it is employed in the construction of hot water service lines.

Wrought iron pipe will have an average life of 10 to 12 years in hot water service lines, whereas the life of steel pipe may be not more than 7 to 9 years. The service life of cold water lines in most plumbing systems is measured by the rate of accumulation of solid matter on the inner surface of the pipe, which stops or restricts the flow of water. For cold water service there is no great difference between steel and wrought iron pipe.

Lead Has High Resistance to Corrosion

By Engineer in Charge of Building Construction

Pipe made entirely of lead is not practical for a complete plumbing installation because of its weight and lack of rigidity. Owing to the flexibility of lead, however, and to its inert quality chemically, it has high resistance to corrosion, for which reason it is used to some extent for those parts of waste systems which are restricted as to space and to which there is no access for repairs.

Some use has been made of lead-lined iron and steel pipe to combine the durability of the lead with the rigidity of the iron and steel, but even when carefully installed the life of this pipe depends on the life of the fittings.

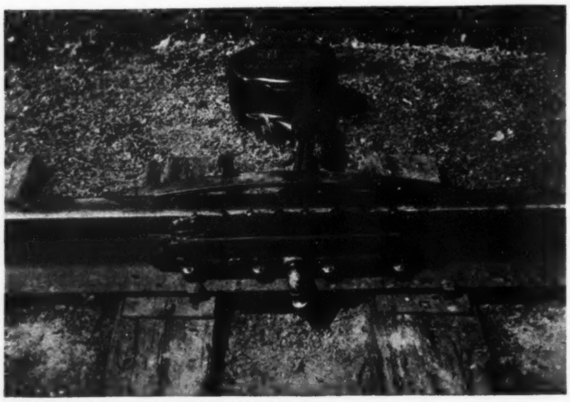
Wrought-iron pipe is probably the most generally satisfactory material for a plumbing installation, where no special problem, such as the disposal of corrosives, is involved. Whether used for water supply or for waste lines, the fact that the pipe is homogeneous material causes it to oxidize uniformly, forming a film which tends definitely to retard further corrosion of the metal.

Wrought-iron pipe is more expensive than steel with respect to first cost, but is worth more than the difference in price for work that is meant to last as long as possible. Steel pipe is generally unsatisfactory for any type of plumbing work owing to its rapid corrosion. Where first cost is important or where the life of the installation is expected to be short, it will serve the purpose, however.

NEW AND IMPROVED DEVICES

Lundie Ardco Rail Lubricator

FOLLOWING two years of development and of test installations about the country, the Lundie Engineering Corporation, New York, is now presenting its Ardco automatic rail and flange lubricator, a mechanically-operated device to be attached to the rail ahead of a curve or series of curves to apply grease to passing wheel flanges and thus to the rail to be lubricated. Essentially, the Ardco unit consists of a grease application plate with a series of grease ports through which the lubricant is presented to the wheels, a grease container, or cylinder, with a piston for forcing the grease to the application plate, and a leaf-type drive spring, operated by the passing wheels, which, through mechanical connections, actuates the container piston.



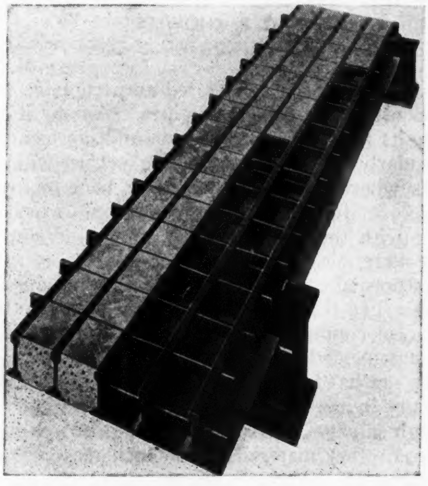
The Ardco Lubricator in Track, Showing the Grease Plate Against the Rail, the Drive Spring Protruding Above the Rail, and the Grease Container in the Background

As installed in the track, the grease application plate is attached to the gage side of the rail, usually from 20 to 30 ft. ahead of the curve to be lubricated, by means of two bolts passing through the rail web, while the drive spring arrangement is bolted directly on the opposite side of the rail in such position that the outer part of the wheel treads impinges on the spring. The downward movement of the spring, as it is struck by the wheels, is transformed by mechanical means into the rotation of a shaft at right angles to the rail, which has connection with the top of the grease container, or cylinder, which is partially buried in the ballast shoulder directly alongside the track.

At the grease container, a worm, gear and screw assembly drives the grease piston upward, forcing the grease out of an opening in the top of the container and thence to the grease application plate and its grease ports along the rail. Throughout, the action of the lubricator is positive, each impulse received by the drive spring forcing a pre-determined amount of grease from the ports. An adjustment screw at the base of the grease application plate makes it possible to regulate the height to which the grease is forced up on the side of the rail. Furthermore; a disengaging device is provided whereby the upward movement of the container piston is stopped automatically when the supply of grease has become exhausted. The grease container is recharged readily by removing a plate on the top of the container, and then, after lowering the grease piston by means of a hand crank, filling the container with grease and replacing the plate. The entire unit is of rugged construction, and it is said that it requires little or no attention other than periodic recharging. It is also said that the machine operates effectively with any commercial grease, and is as positive in operation in winter as in summer.

Carnegie Introduces I-Beam-Lok Floor Slab

A NEW type of floor construction, known as I-Beam-Lok armored slab, is now being offered for use in ballasted deck bridges, as well as for heavy duty floors by the Carnegie Steel Company, Pittsburgh, Pa. This floor design comprises a modification of the T-Tri-Lok floor manufactured by the same company. It varies from the earlier design in that small special I-beams replace the T-bars as the main members of a steel grid that provides the reinforcement and an armored top surface for the concrete filling that is introduced in the field and also



The I-Beam-Lok Armored Floor Slab of the Carnegie Steel Company

provides the form work that supports the concrete until it has set.

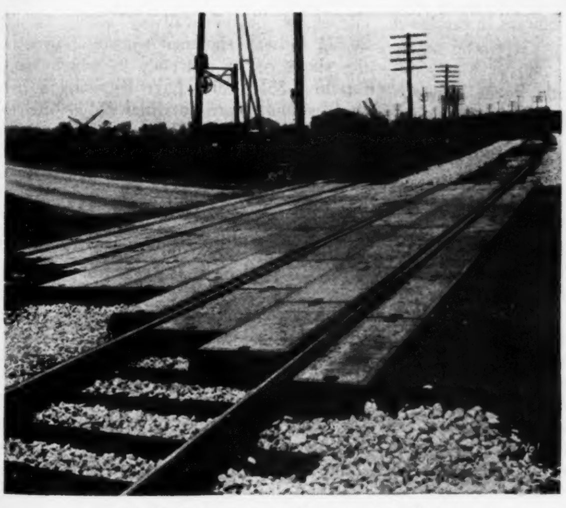
In addition to the I-beams, the design includes cross-bars that provide the reinforcement for the lateral distribution of the load and tie the I-beams together to form a pre-assembled frame that is readily handled in the field. These cross-bars are inserted through slots in the webs of the I-beams and are tack-welded at the intersections. No metal is cut from the I-beam flanges.

Form work for the concrete is provided by metal form strips supported on the lower flanges of the I-beams. These strips are omitted over the top flanges of supporting beams and girders, thereby permitting the concrete to come directly in contact with the bearing areas, and facilitating the welding of the I-beams to the stringer flanges.

The I-beams for this floor may be 3 in. or 3½ in. in depth. The crossbars are spaced 4 in. apart at the top of the slab while at the bottom the spacing is much greater. The slab weighs 47 lb. per sq. ft. in the 3-in. depth and 53.5 lb. per sq. ft. in the 3½-in. depth.

A New Armored Concrete Slab for Highway Crossings

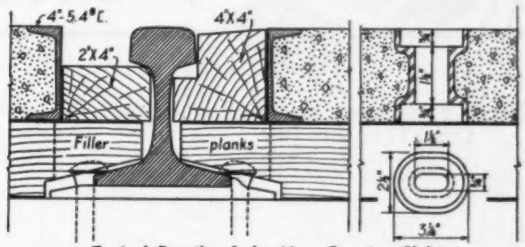
A NEW type of armored concrete highway crossing slab has recently been introduced by the Massey Concrete Products Corporation, Chicago, which differs in a number of respects from slabs previously employed for the same purpose. The slab is reversible—either face can serve as the wearing surface. It is provided with an ingenious recessed fitting that affords a convenient means for lifting and also provides a double countersunk hole for the lag screws used to anchor it to the track ties. The concrete is encased in a steel frame which, it is claimed,



An Installation of the New Crossing Slabs

provides exceptional protection against raveling of the edges under traffic. The slabs are designed to function as simple spans supported only at their ends, for the purpose of avoiding the rocking action that may sometimes occur where intermediate supports are provided.

The depth of the slab, 4 in., is determined by the steel frame, which consists of 4-in. 5.4-lb. steel channels on all four sides, welded at the corners. The reinforcement comprises cold drawn welded wire mesh in two planes, ¾ in. from the faces of the slab. It is said that the concrete used is designed to develop a compressive strength of 6,000 lb. per sq. in. at 28 days. Two widths of slabs are provided, namely, 25 ⅛ in., for use between the rails and 13¾ in. for service outside the rails. All slabs are made 4 ft. 6 in. long, and the instructions for installation provide that the ties shall be spaced 18 in. center to



Typical Details of the New Crossing Slab

center so that the end joints between the slabs will come over every third tie. The slabs are supported on plank fillers placed only on the ties under the end joints, no support being provided on the intermediate ties.

Concreted into the slabs at each end is a cast iron spool that provides a slotted hole, ¾ in. by 1½ in., through which ⅝-in. lag screws are driven to anchor the slabs to the ties. The spools, however, provide a recess ¾ in.

The Slabs Are Easily Lifted

deep on each face of the slab so that the heads of the lag screws can be countersunk with a socket wrench. These holes also serve a useful purpose in lifting the slabs. Eye-bolts with a short hook on the lower end that will just pass through the slotted hole in the spool, are inserted until the hook passes into the lower recess, where it is turned 90 deg., in which position the eye is in the workwise position to receive bars for lifting, as shown in one of the illustrations. Due to the recessing of the spools, the slabs do not have to be "pinched" off a flat surface before they can be lifted. These recesses are filled with pitch after the lag screws have been driven.

The slabs are insulated from the rails by 2-in. by 4-in. sticks that fit under the head of the rail and form the flangeway. A corresponding filler block, cut from a 4-in. by 4-in. stick is introduced outside the rail.

One of the illustrations shows an installation recently completed on the double track main line of the Atchison, Topeka & Santa Fe at McCook, Ill. Another crossing of this type has been installed on the Chicago & North Western at Elmhurst, Ill.

News of the Month • • •

Railroads Have More Equipment on Order Than Last Year

Class I railroads on August 1 had 13,755 new freight cars on order, as compared with 1,187 on the same date in 1933 and 1,572 two years ago, according to reports received by the Car Service division of the American Railway Association. On August 1 this year these railroads also had 35 steam locomotives and 107 electric locomotives on order. On August 1, 1933, there was 1 locomotive on order and on the same date in 1932 there were 6.

Purchases for Seven Months Increase 20 Per Cent

Purchases by the railroads of the United States of fuel and materials and supplies during the first seven months of 1934 approximated $372,000,000, as compared with $227,600,000 during the first seven months of 1933, an increase of nearly 20 per cent. The figures are exclusive of new locomotives and cars. For the first seven months of this year, the purchases included approximately $127,578,000 for fuel, as compared with $94,750,000 in 1933; $27,131,000 for ties, as against $15,440,000 in 1933; and $217,291,000 for miscellaneous materials, including rail, as compared with $117,410,000.

Freight Damage Increases 2.1 Per Cent

Freight loss and damage payments during the first six months of 1934 increased 2.1 per cent as compared with the same period in 1933, according to figures compiled by the Freight Claim division of the American Railway Association. There was, however, an increase of 15.4 per cent in freight carloadings. The total payments for the first half of 1934 amounted to $7,868,229, as compared with $7,707,230 during the first half of 1933, an increase of $160,999. During the first three months payments declined 7.4 per cent, but during the second three months, they increased 12.7 per cent. Loss and damage to fresh fruits, melons and vegetables showed a decrease of 15 per cent during the six-months.

Trucks Carry More L.c.l. Into Kansas Than Railroads

Conclusive evidence that most estimates concerning the extent of highway competition with the railroads are understated has been developed as the result of a survey of highway traffic recently completed in Kansas. This survey, which was made in May by the state planning board, showed that motor trucks are carrying approximately five times as much l.c.l. freight into Kansas as the railroads. It disclosed that, during the month of May, 71,236 tons of freight were carried into Kansas by motor truck and 26,621 tons were carried across the state by the same agency. During the same period the railroads brought only 15,000 tons of l.c.l. freight into the state or slightly more than one-fifth of the amount handled by truck. The survey was made possible by the state "port of entry" law which requires every bus and truck entering Kansas to stop at the border for examination.

Officials Salaries Reduced 34.6 Per Cent, 1929 to 1933

A reduction of $31,717,403, or 34.6 per cent, in the aggregate salaries of railroad executives, officials and staff assistants from 1929 to 1933 is shown in a report compiled by the Bureau of Statistics of the Interstate Commerce Commission. The aggregate official compensation, the report shows, was $94,601,336 in 1929, paid to 16,694 persons, and $62,883,933 in 1933, paid to 12,471 persons. The average salary of this group was $5,667 in 1929 and $5,042 in 1933, a decline of 10.7 per cent, which is less than the percentage reduction in the aggregate salaries, the report explains, because the average salary of the group would tend to increase with the discharge of relatively large numbers of officers in the lower salary groups.

American Railroads Form New Association

The formation of a new association of railroads, known as the Association of American Railroads, to be formed by the consolidation of the Association of Railway Executives and the American Railway Association, was approved by railway executives at a meeting at Chicago on September 21. The new organization, which will deal authoritatively with matters of interest to the railroads of the United States, embodies a concerted effort to protect and advance the railroad industry under private ownership and management and to enable it to deal more effectively with the government in working out a program in the interest of the owners of railroad properties, their employees and the public.

The activities and policies of the association will be directed by a board of 15 directors composed of railroad presidents. J. J. Pelley, president of the New York, New Haven & Hartford, has been elected president of the association and will also act as chairman of the board. Active direction of the association will be in the hands of an executive committee consisting of five members of the board and the president. Other executive officers of the association will include five vice-presidents, one of whom will be the general counsel; an associate general counsel; a general solicitor; and a secretary-treasurer. The organization will embody five departments, each under the direct supervision of a vice-president, as follows: (1) Law, (2) operations and maintenance, (3) traffic, (4) finance, accounting, taxation and valuation, and (5) planning and research.

A biographical sketch, together with a photograph of Mr. Pelley appears elsewhere in these columns.

Big Four Foremen Meet

The Association of Maintenance of Way Foremen, an organization of track, bridge and building and water service foremen on the Big Four railroad, held its annual convention at Cincinnati, Ohio, on August 24-25. A special feature of the meeting was the presentation of reports of committees on Lining Track and on Rules for the Maintenance of Bridges and Structures, both of which aroused active discussion.

P.W.A. Loans Boost Railway Employment

More than half of the $190,950,500 allotted by the Public Works Administration as employment-creating loans to 31 railroad companies has been paid out, and on July 15, the latest date for which complete figures are available, 70,060 men were directly employed as a result of these loans, with probably a considerably greater number indirectly employed. This information was based on a report made to Public Works Administrator Harold L. Ickes by Frank C. Wright, director of the division of transportation loans. Loans totalling $77,075,957 to 19 railroads were providing employment for 35,902 trackmen and other classes of outside railway works, while 20,533 railway shopmen were employed in the shops of 14 railroads to which loans totalling $51,905,043 have been made. As the result of loans totalling $61,969,500 to 18 railroads for the purchase of new equipment, 13,625 men were employed in the shops of locomotive and car building companies throughout the country.

Eastman Believes Prosperity of Railroads Is Essential

"Improvements in the art of transportation already made and those which are pending will be of considerable benefit to the capital goods industries of the country," said Joseph B. Eastman, federal co-ordinator of transportation, in a recent address. A general revival of business would have a "fine effect on the railroads," he continued, "but on the other hand railroad revival would have a most excellent effect on business." Next to the general depression, Mr. Eastman said, the thing which has hurt the railroads most severely has been the greatly increased competition of other forms of transportation, and he reiterated his advocacy of federal regulation of motor and water carriers.

"All transportation agencies need public regulation," Mr. Eastman said, "as a protection against over-development and destructive competition from irresponsible operators in their own ranks and from other transportation agencies."

Association News

The Bridge and Building Association

Preparations are now practically completed for the forty-first annual meeting of the American Railway Bridge and Building Association which will be held at the Hotel Sherman on October 16-18. The program for this meeting is as follows:

Tuesday Morning, Oct. 16

Convention called to order 10:00 a.m.
Invocation
Opening address on Current Railway Problems of the Day by L. C. Fritch, chief operating officer, C.R.I.&P.
Greetings from the Roadmasters and Maintenance of Way Association by C. W. Baldridge, president
Announcements
Committee appointments
Address by Carl S. Heritage, president, bridge engineer, K.C.S., Kansas City, Mo.
Report of Secretary-Treasurer
Report of Committee on The Maintenance of Ballast Deck Trestles, H. I. Benjamin, chairman, special engineer, S.P., San Francisco, Cal.

Tuesday Afternoon (2:00 p. m.)

Report of Committee on The Comparative Cost, Durability and Protective Value of Brush and Spray Painting, C. M. Burpee, chairman, research engineer, D. & H., Albany, N. Y.
Paper on the Programming of Bridge and Building Work, by G. Tornes, superintendent of bridges and buildings, C.M. St.P.&P., Chicago.
Report of Committee on Electric Pumping Equipment, B. R. Kulp, chairman, principal assistant engineer, C.&N.W., Chicago.
Adjournment to visit exhibit of Bridge and Building Supply Men's Association.

Wednesday Morning, Oct. 17 (9:30 a. m.)

Report of Committee on The Relative Economy of Various Culvert Materials, F. M. Lehrman, chairman, designer, bridge department, C.&N.W., Chicago.
Address on Power Equipment on the Bonnet Carre Spillway Structures, by C. C. Westfall, engineer of bridges, I.C.
Report of Committee on The Relative Advantages of Separate As Against Combined Gangs for Bridge and Building Work, H. C. Munson, chairman, trainmaster, C.M.St.P.&P., Ottumwa, Iowa.
Luncheon of members of the American Railway Bridge and Building Association and the Bridge and Building Supply Men's Association.
Address by Samuel O. Dunn, chairman of the board and editor, Railway Age.

Wednesday Afternoon (2:00 p. m.)

Report of Committee on The Relative Merits of Inside Metal and Outside Wooden Guard Rails, C. A. J. Richards, chairman, assistant engineer, Pennsylvania, Chicago.
Report of Committee on Lessons From the Depression; F. E. Weise, chairman, chief clerk, engineering department, C.M.St. P.&P., Chicago.
Roundtable discussion on questions submitted by members.

Thursday Morning, Oct. 18 (9:30 a. m.)

Report of Committee on High-Early-Strength Concrete—Its Place in Bridge and Building Work, L. B. Alexander, chairman, assistant bridge engineer, M. C., Detroit, Mich.
Report of Committee on Means of Interesting Employees in Safety Measures, F. H. Masters, chairman, assistant chief engineer, E.J.&E., Joliet, Ill.
Business session—selection of next meeting place, election of officers, etc.

Bridge and Building Supply Men's Association

Twenty companies have already arranged for participation in the exhibit of bridge and building materials which will be held in connection with the convention of the Bridge and Building Association. With other companies that are now negotiating for space, it is expected that at least 30 manufacturers will participate, approaching the record of previous years. The companies which have arranged for space to date, according to the secretary, John W. Shoop, Lehon Company, Chicago, include:

Barrett Company, New York.
Dearborn Chemical Company, Chicago.
Paul Dickinson, Inc., Chicago.
Duff-Norton Manufacturing Company, Pittsburgh, Pa.
Fairbanks, Morse & Co., Chicago.
Fairmont Railway Motors, Inc., Fairmont, Minn.
High Grade Manufacturing Co., Cleveland, Ohio.
Ingersoll-Rand Co., New York.
Ingot Iron Railway Products Co., Middletown, Ohio.
Johns-Manville Corp., New York.
Lehon Company, Chicago.
Earle A. Mann & Associates, Chicago.
Massey Concrete Products Corp., Chicago.
National Lead Company, New York.
Pittsburgh Plate Glass Co., Newark, N. J.
Pocket List of Railroad Officials, New York.
Railway Engineering and Maintenance, Chicago.
Ruberoid Company, New York.
U. S. Wind Engine & Pump Co., Batavia, Ill.
Zitterell Mills Co., Webster City, Iowa.

American Railway Engineering Association

Ten committees held meetings in September to complete their reports and insure that they will be in the hands of the secretary by November 1. These committees were Buildings, at New York, on September 6 and 7; Economics of Railway Labor, at Chicago, on September 7; Economics of Railway Operation, at Cleveland, Ohio, on September 12; Masonry, at Chicago, on September 13 and 14; Maintenance of Way Work Equipment, at Chicago, on September 18; Track, at Chicago, on September 18 and 19; Roadway, at Chicago, on September 19; Ties, at Kansas City, Mo., on September 25 and 26; Economics of Railway Location, at Pittsburgh, Pa., on September 25; and Grade Crossings, at Chicago, on September 28. In connection with the meeting of the Tie committee, an inspection of tie yards was made between Kansas City and Galesburg, Ill.

Among the committees that will hold final meetings in October are Uniform General Contract Forms, at New York, on October 1; Wood Preservation and Rivers and Harbors, both at Chicago, on October 2; Iron and Steel Structures, at Philadelphia, Pa., on October 4 and 5; Waterproofing, at Baltimore, Md., on October 11 and 12; Water Service, Fire Protection and Sanitation, at Chicago, on October 16 and 17; Wooden Bridges and Trestles, at Chicago, on October 19.

The first copies of the Proceedings were issued during the week of September 24, and copies will be mailed to members as they are received from the bindery.

Maintenance of Way Club of Chicago

The first meeting of the club this fall will be held on Wednesday evening, October 17, when H. R. Clarke, engineer maintenance of way, of the Chicago, Burlington & Quincy will give a talk on improvements in the track structure which must be made to meet the operating requirements of the new high-speed trains.

Average Load Per Freight Car Gradually Increasing

Despite the lower total volume of freight carried by the railroads in recent years, the average load per car of carload freight has been gradually increasing, according to tabulations compiled by the Car Service division of the American Railway Association. For all carload traffic, which includes agricultural products, minerals, livestock and forest products, as well as manufacturers and miscellaneous freight, the average load per car was 35½ tons in 1933. This was 3/5 of a ton greater than in 1932 and 1/5 of a ton greater than in 1931. With the exception of 1930, when the average load was 35 7/10 tons, the average for 1933 was greater than for any year since 1922 when these reports were first made.

Class I Roads File Petition for Rate Increase with I.C.C.

On August 27 the Class I railroads of the United States filed a petition with the Interstate Commerce Commission asking for authority to increase their freight rates as a means of producing increased revenues to offset in part the increases in the expenses of the railroads that have come about due to the effects of the "new deal." In general, the increases requested amount to 10 per cent but with many exceptions and with maximum or specific increases on many commodities which will bring the average down to about 7 per cent, or approximately $170,000,000 a year. The increases in the railroads' expenses that have been caused by higher wages and unit costs of materials and supplies amount to about $293,000,000 a year.

Personal Mention

General

W. A. Mather, assistant to the vice-president of the Canadian Pacific, with headquarters at Montreal, Que., and formerly a resident engineer with this company, has been promoted to general manager of the Western Lines, with headquarters at Winnipeg, Man.

John J. Pelley, president of the New York, New Haven & Hartford, whose election as president of the newly-formed Association of American Railroads is noted elsewhere in this issue, spent his early years of railway work in the maintenance of way department. Mr. Pelley was born on May 1, 1878, at Anna, Ill., and entered railway service as a track apprentice on the Carbondale division of the Illinois Central. He was promoted to supervisor on the Indiana division in 1904 and was transferred to the Memphis division in the following year. This was followed in 1908 by his promotion to roadmaster of the Louisiana division, with headquarters at McComb, Miss., and from there he was transferred to the Tennessee division, with headquarters at Fulton, Ky., in 1911. Mr. Pelley entered the operating department in 1912 as superintendent of the Tennessee division and in 1917 was promoted to general superintendent of the Southern Lines, with headquarters at New Orleans, La. Mr. Pelley later retired temporarily from the service of the Illinois Central to engage in work with the Car Service division of the American Railway Association but returned to that road on April 1, 1923, as general manager. He was promoted to vice-president in December, 1924, and in September, 1926, was elected president of the Central of Georgia. He was elected to a similar position with the N.Y.N.H. & H. in 1929.

John J. Pelley

Chester A. Johnston, division engineer on the Wabash, with headquarters at Montpelier, Ohio, has been appointed superintendent of the St. Louis Terminal division at St. Louis, Mo. He was born on September 1, 1895, at Logansport, Ind., and was educated at Purdue University and at the University of Arizona. He entered railway service in 1917 on the engineering corps of the Pennsylvania at Louisville, Ky., being transferred to Indianapolis, Ind., after three years and then to Terre Haute, Ind., in 1922. He left the Pennsylvania to go with the Wabash in 1924 as assistant engineer at Decatur, Ill., and in 1926 he was appointed resident engineer in charge of second track construction at Adrian, Mich. Following the completion of this work in 1927, Mr. Johnston was appointed track supervisor of the Chicago Terminal division. Two years later he was advanced to division engineer of the Detroit division where he was appointed superintendent in 1930. In 1932 he was appointed division engineer of the Montpelier division, with headquarters at Montpelier, where he was located at the time of his recent appointment as superintendent, St. Louis Terminal division.

Engineering

Lorenzo Perez Castro, formerly executive vice-president of the National Railways of Mexico, has been appointed resident engineer of the Mexican Railway, with headquarters at Mexico City, Mex., succeeding **A. M. Willats,** who has resigned.

W. C. Perkins, general roadmaster of the Oregon Short Line (part of the Union Pacific System), with headquarters at Pocatello, Ida., has been promoted to division engineer of the Kansas division of the Union Pacific Railroad, with headquarters at Kansas City, Mo., succeeding **L. I. Hammond.**

H. L. Hunter, who was assistant engineer in charge of the recently completed track elevation project of the Atchison, Topeka & Santa Fe, at Oklahoma City, Okla., has been appointed office engineer in the chief engineer's office at Topeka, Kan., succeeding **W. A. Kingman,** who has been appointed office engineer on the Middle division, with headquarters at Newton, Kan.

J. T. Sturman, assistant division engineer on the Reading, with headquarters at Reading, Pa., has been appointed assistant to the general superintendent, in charge of maintenance. **J. C. Wrenshall,** engineer maintenance of way, with headquarters at Reading, has been retired at his own request, and the office of engineer of maintenance of way has been abolished.

Mr. Wrenshall was born on August 12, 1868, at Baltimore, Md., and was educated at the University of Virginia. He entered railway service on June 1, 1891, as an assistant supervisor on the Baltimore & Ohio at Cumberland, Md. In the following year he was promoted to supervisor at Hagerstown, Md., and in 1895 he was transferred to Baltimore. In 1898, he was appointed division engineer at Cumberland, being transferred to Washington, D. C., in 1899. In the following year Mr. Wrenshall became a transitman in the chief engineer's department of the Philadelphia & Reading, and shortly thereafter was appointed supervisor at Lebanon, Pa. In 1902, he was transferred to Harrisburg, Pa., and in 1903, to Trenton, N. J. In 1905, he was promoted to division engineer at Harrisburg, and in 1910, he was transferred to Reading, Pa. In 1918, he was appointed division engineer of the New York division, with headquarters at Philadelphia, and in November, 1923, he was advanced to engineer maintenance of way, which position he was holding at the time of his retirement at his own request.

Track

R. R. Rex, supervisor of track on the New York Central, with headquarters at Kentland, Ind., has been transferred to Kankakee, Ill., to succeed **C. H. Rachor,** deceased. Mr. Rex retains jurisdiction over his former territory. **R. C. Hager,** assistant chief clerk in the chief engineer's office at Chicago, has been appointed assistant supervisor of track at Kentland under Mr. Rex. **P. Margraf,** supervisor at Chicago, has been transferred to Michigan City to succeed **J. D. Elder,** assigned to other duties.

M. Kubin, whose appointment as roadmaster on the Canadian Pacific, with headquarters at Grand Forks, B. C., was announced in the August issue, was born on August 8, 1886, in Checkoslovakia. He entered railway service with the Canadian Pacific in 1905 as a trackman at Beavermouth, B. C., and has been connected with this company continuously until the present. In August, 1907, he was promoted to track foreman at Twin Butte, B. C., and served in this position on numerous sections on the Shuswap, Mountain and Boundary subdivisions. While located on the Mountain sub-division he served for four years as track foreman in charge of the Connaught tunnel. Just prior to his recent appointment as roadmaster, he acted as extra gang foreman in charge of the laying of 130-lb. rail between Field, B. C., and Revelstoke.

E. A. Buskirk, roadmaster on the Oregon-Washington Railroad & Navigation Co., with headquarters at Pendleton, Ore., has been promoted to general roadmaster of the Oregon Short Line, with headquarters at Pocatello, Ida., succeeding **W. C. Perkins,** whose appointment as division engineer is noted elsewhere in these columns. Both railroads are parts of the Union Pacific System.

Mr. Buskirk was born in October, 1879, at South Bend, Neb., and entered railway service in March, 1898, as a timekeeper on the Chicago, Burlington & Quincy, later serving as a laborer and track foreman. He went with the Union Pacific in April, 1901, as a track foreman on the Nebraska division, being promoted to roadmaster on the Western division in October, 1917. In November, 1921, Mr. Buskirk was transferred to the O.-W. R. R. & N. where he served as roadmaster at Pendleton from 1924 until his recent promotion to general roadmaster at Pocatello.

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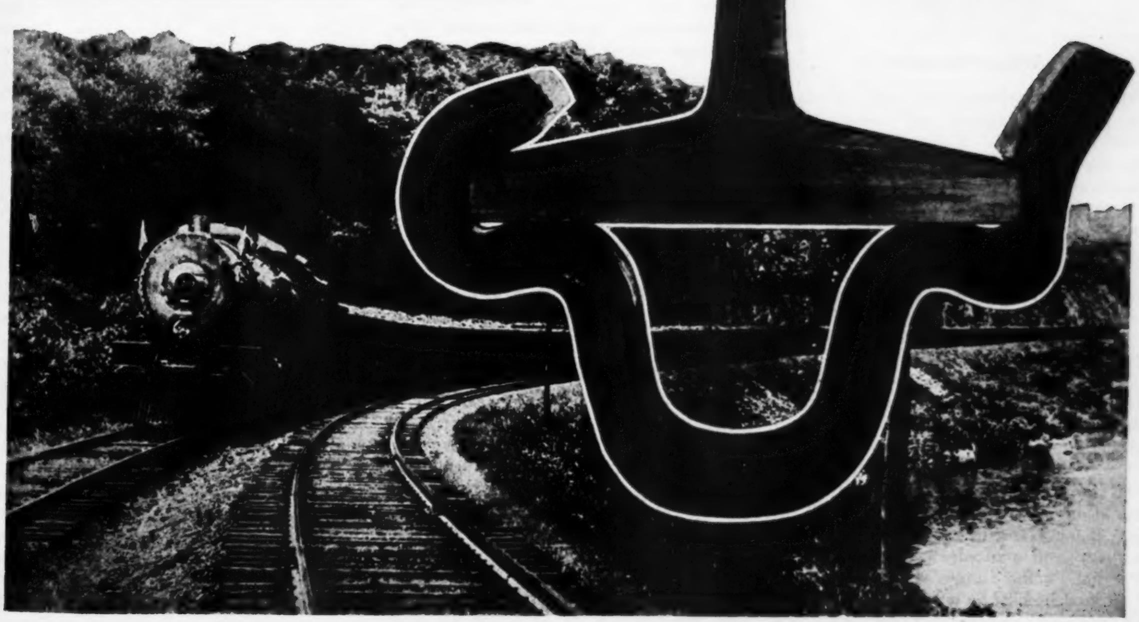

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Obituary

C. H. Rachor, supervisor of track on the New York Central, with headquarters at Kankakee, Ill., died on August 21.

William M. Jaekle, engineer maintenance of way and structures of the Southern Pacific, Pacific Lines, with headquarters at San Francisco, Cal., died on September 3 of a heart attack, following a brief illness. Mr. Jaekle had served in engineering capacities with various railroads for 30 years and had been engineer maintenance of way and structures of the Southern Pacific since the spring of 1932. He was born on January 9, 1883, at Brooklyn, N.Y., and received his engineering education at Cooper Institute. He obtained his first railway experience in 1904 as a transitman on the New York division of the Erie, and a year later he joined the Missouri Pacific as an assistant engineer at St. Louis, Mo. Mr. Jaekle, however, soon left this company to go to Mexico where he served until 1907 as a transitman and chief of party on railroad location and construction with the National Railways of Mexico. He then joined the Southern Pacific as assistant engineer at Sacramento, Cal., where he was made assistant division engineer in 1909. In the following year he went with the Oregon-Washington Railroad & Navigation Co. (then affiliated with the Southern Pacific) as division engineer at Portland, Ore. In 1913 he returned to the Southern Pacific as division engineer at Bakersfield, Cal., being transferred to Los Angeles four years later. During federal control of the railroads, Mr. Jaekle acted as engineer of maintenance of the lines south of Portland and west of Ogden, Utah, and El Paso, Tex. Following the termination of federal control in 1920, he was made assistant engineer maintenance of way and structures of the Southern Pacific, Pacific Lines, at San Francisco, Cal., and in 1932 he was further advanced to engineer maintenance of way and structures.

William M. Jaekle

John Winstead, colored laborer on the Chesapeake & Ohio at Lambert Point, Va., is the fattest railroader. He is 5 ft. 7 in. tall and is reported to weigh from 370 to 400 lb.

Supply Trade News

General

The Buhl Sons Company, Detroit, Mich., has been appointed distributors of Toncan iron by the **Republic Steel Corporation,** Youngstown, Ohio.

The Houck Manufacturing Company, Brooklyn, N. Y., has purchased the assets and good will of the oil burner division of the Mead-Morrison Manufacturing Company, East Boston, Mass., and will continue the manufacture of, and stock spare parts for, rivet forges and portable torches produced heretofore by the latter company.

Consolidation of the **Republic Steel Corporation,** Youngstown, Ohio, and the **Corrigan, McKinney Steel Company,** Cleveland, Ohio, was approved at meetings of the boards of directors of both companies on August 27, subject to ratification by the stockholders. A special stockholders meeting of the Republic Steel Corporation has been called for October 30, at which stockholders will vote on the merger. The merger involves a readjustment of the Republic's capital structure and $24,000,000 of new financing for the combined companies. The enlarged enterprise will have assets of approximately $323,000,000.

Personal

P. H. Birckhead has been appointed general sales manager of the **Bucyrus-Erie Company,** South Milwaukee, Wis., in charge of domestic and foreign sales.

E. L. Ruby, president of the Ruby Railway Equipment Company, Philadelphia, Pa., died on September 9 at his home at Jenkintown, Pa., following two years of ill health.

Melvin Pattison, executive vice-president and secretary of the **Industrial Brownhoist Corporation,** Bay City, Mich., has been elected president and treasurer, succeeding **Alexander C. Brown,** who has resigned to become first vice-president of the Cleveland Cliffs Iron Company, Cleveland, Ohio. Mr. Brown will continue as a director of the Industrial Brownhoist Corporation. **Edward S. Clark,** who has been a director of Industrial Brownhoist since 1917, has been elected secretary. **Hoyt E. Hayes,** export sales manager and manager of sales in the Cleveland district, has been elected vice-president and sales manager. **George A. Long,** plant manager and assistant secretary, has been elected vice-president, in charge of manufacturing, also retaining the position of assistant secretary. **James B. Hayden,** sales engineer, has been appointed assistant sales manager.

John C. Dilworth, for many years associated with the Dilworth Porter Company, Pittsburgh, Pa., has severed his association with that company and has joined the sales force of the **Carnegie Steel Company,** as manager of railway sales with headquarters at Pittsburgh. Mr. Dilworth will handle for the Carnegie Steel Company all railway specialties and supplies. He was graduated in 1905 from Sheffield Scientific School of Yale University, and also attended Shadyside Academy in Pittsburgh and St. Paul's Preparatory school. Mr. Dilworth went with the Dilworth Porter Company immediately after his graduation from Yale and for years was in the operating department of the industry, later taking up the sales end.

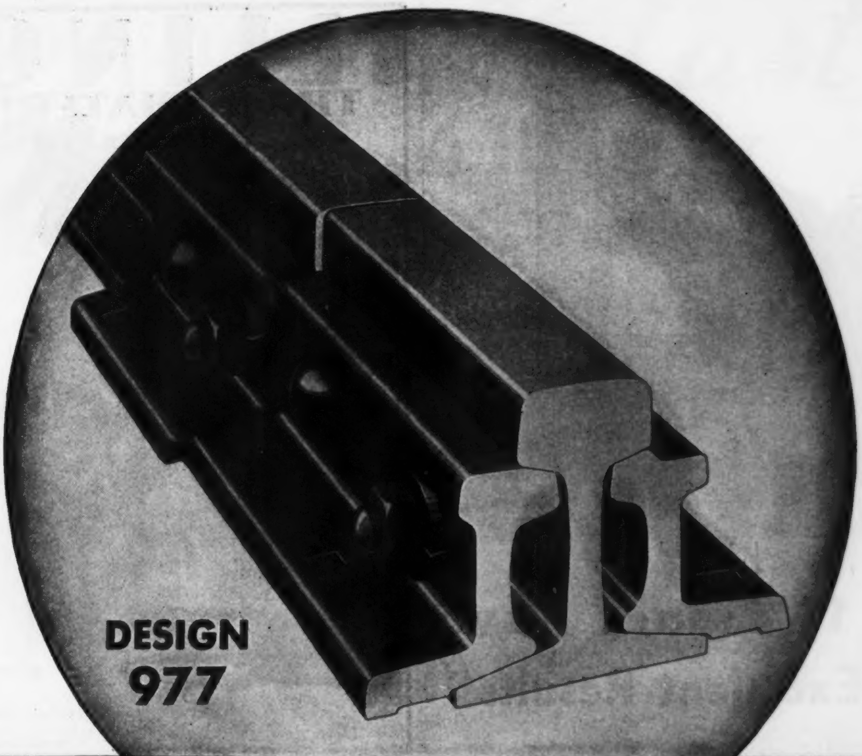
John C. Dilworth

Trade Publication

Utility Air Hoists—A 32-page booklet has been issued by the Ingersoll-Rand Company, New York, which covers the complete line of single and double-drum Utility air hoists manufactured by the company. The booklet discusses in detail, with drawings and tables, the construction and operating features of the different hoists, and by numerous illustrations shows the many uses of the hoists in construction and for various other types of work.

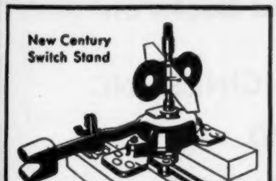
Personal Interviews Promote Safety on New Haven

That personal interviews between the division department heads and the employees under their jurisdiction comprises an effective means of promoting safety has been demonstrated on the Providence division of the New York, New Haven & Hartford, which in 1933 won the system yard safety prize, the freight-house prize and the train, yard and engine service prize on this railroad. The outstanding safety record on this division is attributed to the practice followed by the superintendent and the assistant superintendent of giving a safety interview to each employee of the division operating department. In addition to the interview itself, specific instances of unsafe practices that have been or might be applicable to his own job or his territory are cited to the employee, and he is encouraged to give his ideas as to the promotion of safety. The division engineer and the master mechanic are also following this plan in their departments.



A RUGGED COMPROMISE JOINT

OTHER BETHLEHEM TRACK EQUIPMENT


New Century Switch Stand


Hook Flange Guard Rail


Adjustable Rail Brace 813


Heat-treated rail crossing

WHEN rails of different sections are joined, the abrupt change in width and contour of the rail head, and in the location of the vertical web, results in stresses of a type and severity which call for a much sturdier job than the ordinary rail-joint. Bethlehem Rolled Steel Compromise Joint, Design 977, was developed with a view to combining the design and material best suited to stand the wear-and-tear of this service.

This compromise joint consists of two standard rolled-steel angle bars. Forged to fit the fishing spaces of the two sections. Providing an extra-heavy head, web and flange that give a maximum of both vertical and lateral stiffness. The heating and forging process refines the grain structure of the metal, thereby increasing the strength and resilience of the rolled section.

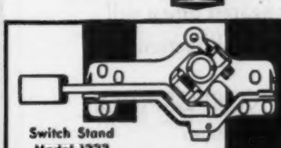
The two bars of the joint are so offset, horizontally and vertically, that when bolted to opposite sides of the rails the gage-lines and surfaces are brought into alignment. Spike notches are punched to register with spike holes in tie plates, when so specified.

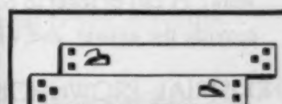
Two Other Designs

Two other Bethlehem Compromise Joints find frequent application. They are Design 972, a cast-steel joint for connecting girder and tee rails, and Design 976, forged or machined from heavy flat bars. Design 976 is an excellent joint for use where conditions do not call for the rugged strength of Design 977.

BETHLEHEM STEEL COMPANY
GENERAL OFFICES: BETHLEHEM, PA.


Bethlehem Gage Rod


Switch Stand Model 1222


Twin Frog Plate

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